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- Whitney Technology
- Q-Bus
- Matrix Printing
- Disk Back-Up

Industry Spotlight

James Baker of
General Electric on

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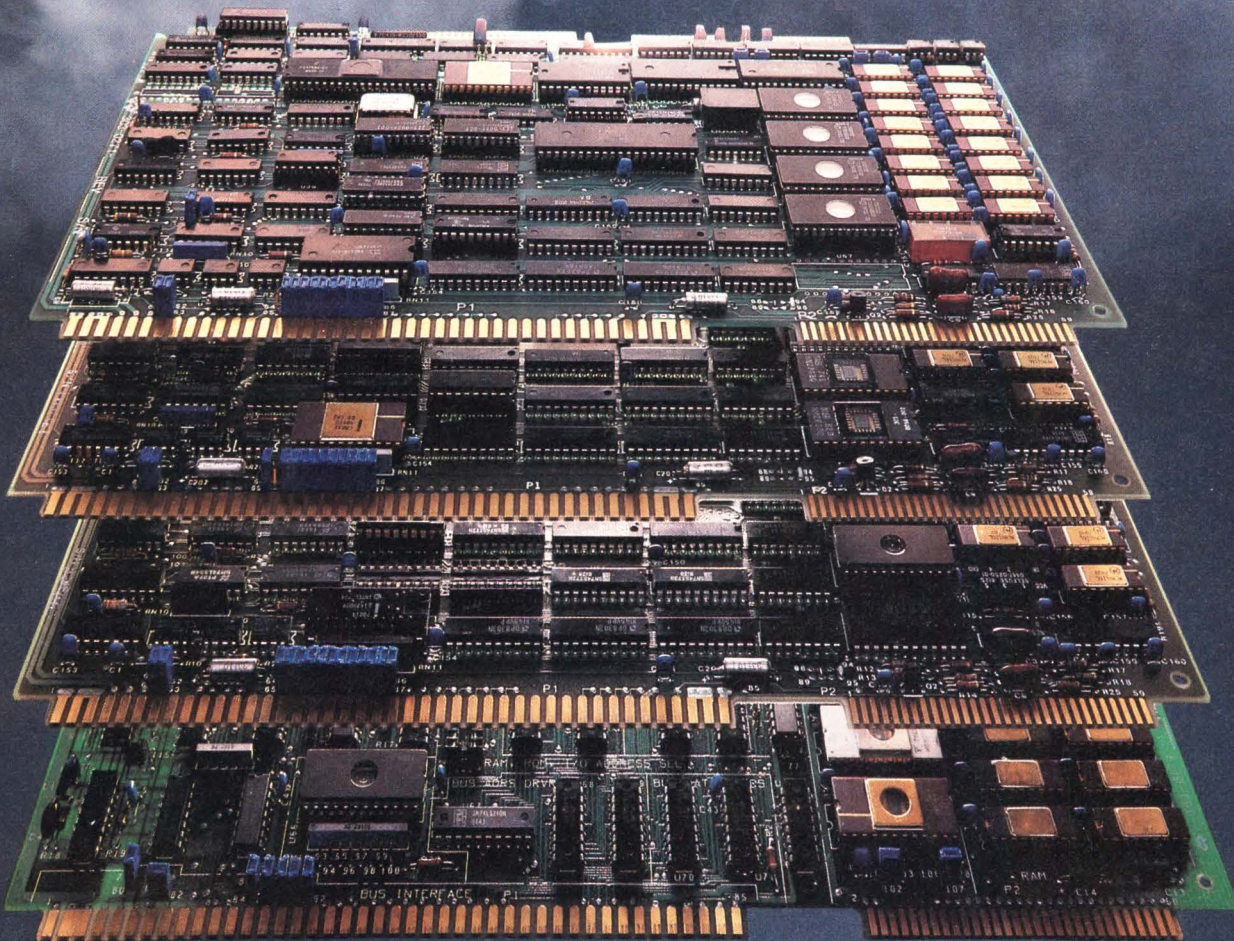
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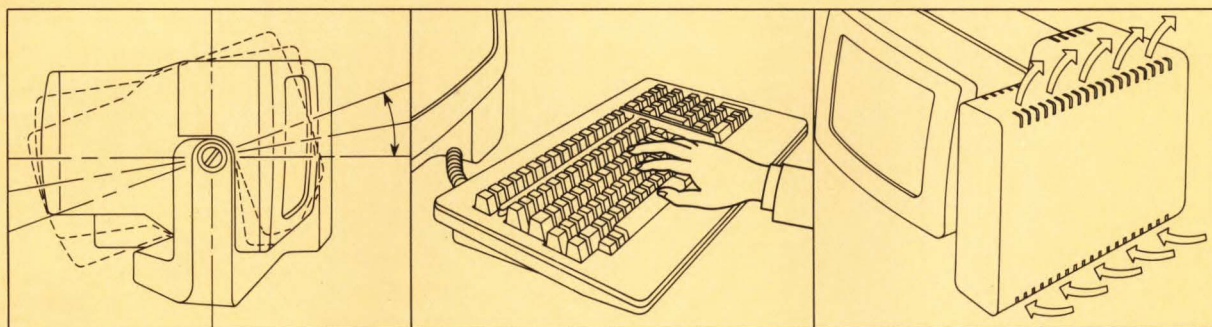
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The new 970 from TeleVideo. Nothing else looks like it. Nothing else performs like it.



Productive office work depends on people and their equipment working efficiently together.

That's why we have engineered the exciting, new TeleVideo 970 to perform better than any other terminal.

For instance, only our "natural balance" tilting mechanism lets you easily adjust the screen at a touch, so you avoid neck-craning, straining and glare.

Our unique keyboard is designed to avoid user fatigue. We've created a natural palmrest, sculpted keys and the best ten-key accounting pad in the industry. Our non-volatile function keys save time and energy.

Like every feature of the new 970, the screen is designed for ease of use. Our non-glare 14-inch green screen is restful on the eyes, and its 132 column display can format more information. All in highly legible double-high, double-wide characters.

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The new 970 from TeleVideo. Nothing else looks like it and nothing else can perform like it.

For more information about TeleVideo's new 970, call 800-538-8725; in California 408-745-7760.

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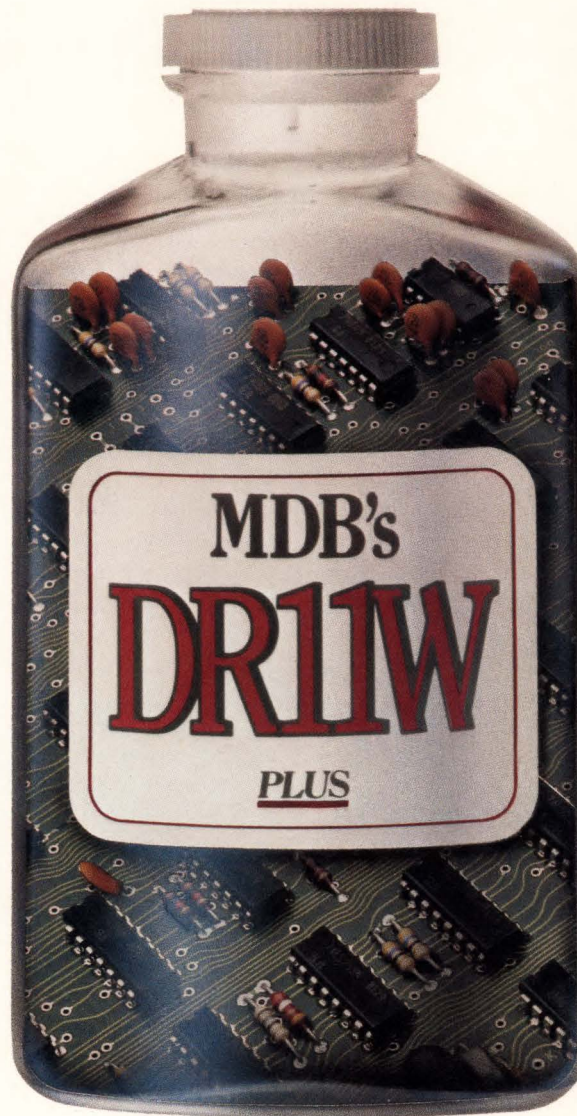
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- Switch selectable, 4-level or single level interrupt arbitration (Q-Bus)
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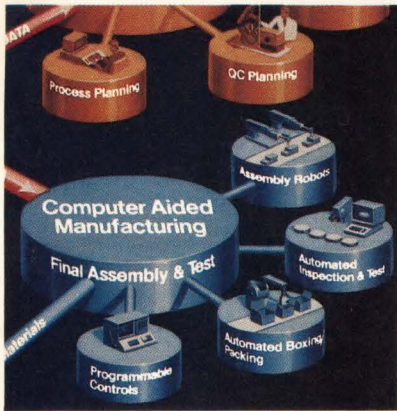
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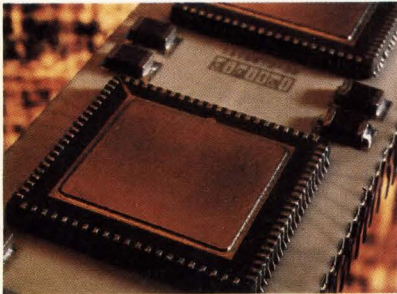
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Digital Design



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(photo courtesy GE)



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(photo courtesy DEC)



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(photo courtesy Mnemos)

Cover

No longer merely executive accessories, portable computers can now be found anywhere from the factory floor to remote geological survey sites—and on the desks of many system designers. This month's coverage of portable computers begins on p. 78. (Cover photo by Epson America, Inc.; cover design by Henry Jackson, Benjamin Morse Inc.)

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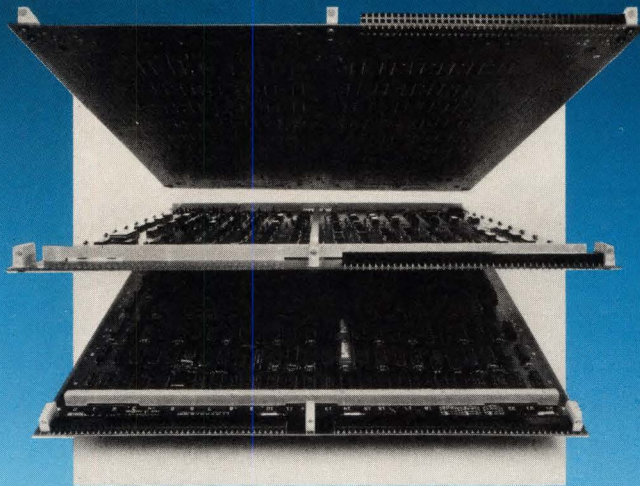
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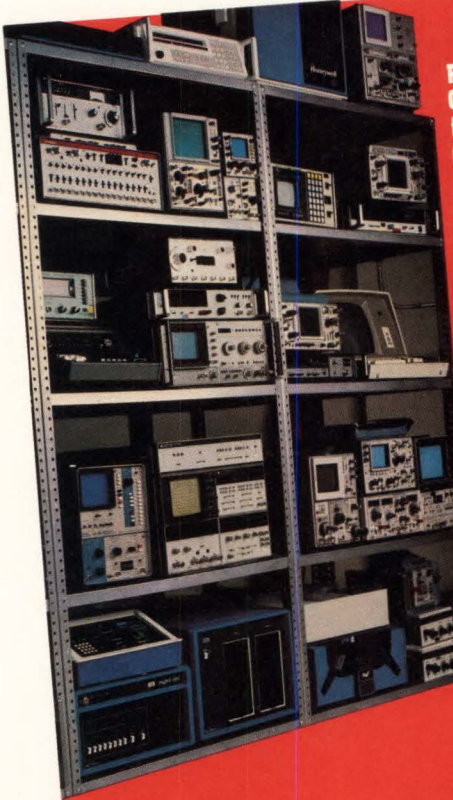
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Mt. Everest, symbolic of aiming high, was generated on the Lundy T5680 raster. It offers 16 colors and 136 shades from a palette of 4,096 colors.



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March 31–April 1

VLSI Technology, Systems and Applications. International Symposium Taipei, Taiwan, Republic of China. Contact: Dr. H.N. Yu, IBM T.J. Watson Research Center, P.O. Box 218, Yorktown Hgts., NY 10598.

April 4–8

Computers/Graphics in The Building Process '83. The Second Annual International Congress, Convention Center, Washington, D.C. Contact: National Computer Graphics Association, Inc., 2033 M Street, N.W., Suite 333, Washington DC 20036. (202) 775-9556.

April 5–6

Symposium on Automated Integrated Manufacturing. San Diego, CA. Contact: Symposium General Chairman, Leonard B. Gardner, P.E., 2406 Buttetop Pl., Spring Valley, CA 92078. (714) 464-2446.

April 5–8

Communications Tokyo. Tokyo Ryutsu Ctr, Tokyo, Japan. Contact: Clapp & Poliak International, P.O. Box 70007, Washington, DC 20088. (301) 657-3090

April 5–8

Intermag Conference. Philadelphia, PA. Contact: C.D. Graham, Jr., Department Materials Science, University of Pennsylvania, 3231 Walnut St., Philadelphia, PA 19104.

April 6–7

Hewlett-Packard Productivity '83 Showcase. Philadelphia, PA. April 19–21, Detroit, MI. Contact: Mary Danehower, Hewlett-Packard, 3000 Hanover St., Palo Alto, CA 94304. (408) 996-9800 x2873.

April 6–8

International Optical Computing Conference. Cambridge, MA. Contact: S. Horvitz, P.O. Box 276, Waterford, CT 06385. (203) 447-4270.

April 7

California Computer Show. Palo Alto Hyatt, Palo Alto, CA. Contact: Norm DeNardi Enterprises, 289 S. San Antonio Rd., Suite 204, Los Altos, CA 94022. (415) 941-8440.

April 7–10

Computer Showcase Expo. Chicago, IL. April 21–24, St. Louis, MO. April 28–May 1, South Florida. Contact: The Interface Group, 160 Speen St., PO Box 927, Framingham, MA 01701. (617) 879-4502.

April 11–13

Engineering Software. Third International Conference and Exhibition. Imperial College, London, England. Contact: Conference Secretary, 125 High Street, Southampton SO1 0AA, England. Tel. (0703) 21397. Telex. 47388, Attn: COMPMECH.

April 11–14

Southeastcon '83. Conference and Exhibit, Orlando, FL. Contact: Russell E. Theisen, Southeastcon '83 Chairman, Martin Marietta Aerospace, P.O. Box 5837 MP-3, 2667 Fitzhugh Road, Winter Park, FL 32792. (305) 671-4139.

April 11–15

Intergraphics '83. Tokyo, Japan. Contact: World Computer Graphics Association, 2033 M St. NW, Suite 250, Washington, DC 20036. (202) 775-9556.

April 12–14

Federal DP Expo. 9th Annual Conference and Exposition for the Federal ADP Community, Washington, DC Convention Center, Washington, DC. Contact: The Interface Group, 160 Speen Street, P.O. Box 927, Framingham, MA 01701. (617) 879-4502 or Toll Free (800) 225-4620.

April 12–15

Computer Network Design & Protocols. Course in packet switching in layered architectures. Boston, MA. Contact: Integrated Computer Systems, 3304 Pico Blvd., PO Box 5339, Santa Monica, CA 90405.

April 12–15

Hardware Design Course. "Designing Real-Time Hardware for Digital Signal & Image Processing. Boston, MA. April 26–29, San Francisco, CA; May 3–6, Washington, DC. Contact: Integrated Computer Systems, 3304 Pico Blvd., PO Box 5339, Santa Monica, CA 90405. (213) 450-2060.

April 13–20

Hanover Fair '83. Hanover, West Germany. Contact: Hanover Fairs Information Center, P.O. Box 338, Whitehouse, N.J. 08888. (201) 534-9044 or Toll Free (800) 526-5978.

April 14–16

IEEE International Conference on Acoustics, Speech and Signal Processing. Boston, MA. Contact: Richard Kurth, Sperry Research Center, 100 North Rd., Sudbury, MA 01776. (617) 369-4000 ext. 306.

April 15–20

IEEE Tutorials on Computers in Industry. Hanover, Germany. Contact: Tutorial Week Europe 83, P.O. Box 639, Silver Spring, MD 20901. (301) 589-3386.

April 17–22

Infocom '83. San Diego, CA. Contact: IEEE Infocom 83, P.O. Box 639, Silver Spring, MD 20901. (301) 589-3386.

April 18–20

1983 ICCCM Conference. The Fifth International Conference on Computer Capacity Management. New Orleans, LA. Contact: Dr. Armand Inselberg, Institute for Software Engineering, 510 Oakmead Pkwy, Sunnyvale, CA 94086. (408) 749-0133.

April 19–21

PCI Motorcon Conference and Exhibition. Orlando, FL. Contact: Earl Nickel, PCI/Motorcon, 2909 Ocean Drive, Oxnard, CA 93030. (805) 985-1595.

April 19–21

Electro/83 and Mini/Micro-Northeast. High Technology Electronics Exhibition and Convention, New York Coliseum and Sheraton Center, New York, NY. Contact: Electronic Conventions, Worldway Postal Center, PO Box 92275, Los Angeles, CA 90009. (800) 421-6816.

April 20–22

Intelligent Copier/Printers Seminar. Andover Inn, Andover, MA. Contact: Institute of Graphic Communication, 375 Commonwealth Ave., Boston, MA 02115. (617) 267-9425.

April 20–22

Symposium on Computer-Aided Geometry Modeling. Hampton, VA. Contact: John Shoosmith, MS 125, NASA Langley Research Center, Hampton, VA 23665. (804) 827-3466.

April 21–22

Pittsburgh Conference on Modeling and Simulation. Pittsburgh, PA. Contact: William G. Vogt or Marlin H. Mickle, Modeling and Simulation Conference, 348 Benedum Engineering Hall, University of Pittsburgh, Pittsburgh, PA 15261.

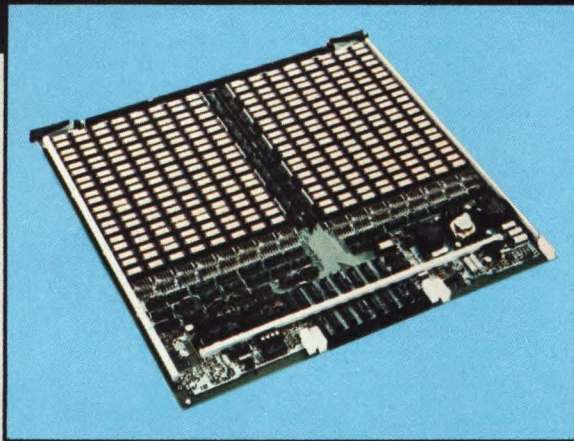
April 25–27

Autofact Japan. An International Conference and Exposition of Automated Manufacturing for Japanese Productivity. Kobe, Japan. Contact: Computer and Automated Systems Association of SME, One SME Drive, P.O. Box 930, Dearborn, MI 48128. (313) 271-1500.

April 25–27

ACM Symposium on Theory of Computing. Boston, MA. Contact: David S. Johnson, Room 2C-355, Bell Laboratories, Murray Hill, NJ 07974.

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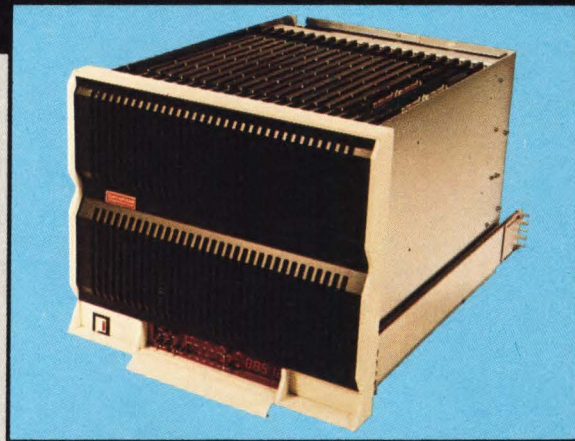
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Dataram Corporation, the leader in Perkin-Elmer compatible memory, introduces two new memory products for the Perkin-Elmer 3200 — with storage capacities from 256KB to 128MB. A dramatic demonstration of our ongoing commitment to Perkin-Elmer users, these new memory products are the latest in an impressive family of products that has been meeting the memory needs of the minicomputer market since 1967.

Both feature speed, capacity, reliability, performance...and low price. Features you won't find in memory from any other Perkin-Elmer memory supplier. Products such as high-performance BULK SEMI that are available only from Dataram. All good reasons why Perkin-Elmer users should look to Dataram when they're looking to perk up their 3200 Series computers.

Dataram 2.0MB DR-330 semiconductor ADD-IN memory operates across the complete range of Perkin-Elmer 3200 Series — 3210, 3220, 3230, 3240 and 3250. Smaller capacities of 1.0MB, 512KB, and 256KB are also available and all are compatible with Perkin-Elmer memory management and ECC. Sockets are standard and a spare on-board RAM is provided. These simple-to-install, highly reliable memory boards are backed up by Dataram's standard one-year warranty.

Write or call now for more information:
Dataram Corporation,
Princeton Road, Cranbury, NJ 08512
609-799-0071



32MB BULK SEMI

Dataram's new BS-702, the industry's only high-performance BULK SEMI to interface to Perkin-Elmer's 3200 Series. With everything you need to get optimum performance from your 3200 system. Compact size — 32 MB in 15 1/4". The I/O driver required to support the BS-702. And the impressive capability to drive up to four 32MB chassis...for a whopping capacity of 128MB!

Solid-state speed enables the BULK SEMI to run at the full SELCH rate of 4.0MB/sec. More than that, solid-state technology means high reliability, further enhanced by standard Dataram features like error correcting and off-line test capability.

And when you talk about capability, you'll talk about the BS-702's unique dual-port operation that allows you to bring your image processing, array processing, or data acquisition input in on one port and off-load to your 3200 on the other.

DATARAM
CORPORATION

April 25-27

1983 Symposium on Security and Privacy. Oakland, Berkeley, CA. Contact: Marvin Schaefer, DOD Computer Security Center, Ft. George C. Meade, Maryland 20755. (301) 859-6880.

April 25-27

Workshop on Software Engineering Technology Transfer. Miami Beach, FL. Contact: Richard Morton, EEIS Co., 401 North Washington St., Rockville, MD 20850. (301) 340-5278.

April 26-27

1983 Conference on Artificial Intelligence. Rochester, Michigan. Contact: Prof. Nan K. Loh, Center for Robotics and Advanced Automation, School of Engineering, Oakland University, Rochester, MI 48063.

April 26-28

Info Manufacturing '83. Exposition and Conference. McCormick Place, Chicago, IL. Contact: Clapp & Poliak, Inc., 708 Third Avenue, New York, NY 10017. (212) 661-8010.

April 26-28

Hi-Tech '83. McCormick Place, Chicago, Illinois. Contact: Clapp & Poliak, Inc., 708 Third Ave., New York, NY 10017. (212) 661-8410.

April 27-29

Satellite and Computer Communications International Symposium. Versailles, France. Contact: T. Bricheteau, Secretariat de Symposium, Domaine de Voluceau, Rocquencourt, BP 105, 78153 Le Chesnay Cedex, France. Tel 3/954.9020; Poste 600.

April 27-30

Northern Computer Fair. Birmingham, England. Contact: Ian Carter, Advertisement Manager, Practical Computing, Quadrant House, The Quadrant, Sutton, Surrey SM2 5AS. Tel. 01-661-3500.

May 1-3

Document-Based Optical Mass Memory Systems. Highlands Inn, Carmel, CA. Contact: Institute for Graphic Communication, 375 Commonwealth Ave., Boston, MA 02115. (617) 267-9425.

May 4-6

Rocky Mountain Data Processing Expo. Currigan Hall, Denver, CO. Contact: Industrial Presentations West, 3090 S. Jamaica Court, Suite 304, Aurora, CO 80014. (303) 696-6100.

May 9-11

VLSI Design. A Structured Approach to Custom IC Design. Boston, MA. Contact: Hellman Associates, Inc., 299 S. California Ave., Palo Alto, CA. 94306. (415) 328-4091.

May 9-13

Graphics Interface '83. Edmonton, Canada. Contact: Graphics Interface '83, CIPS Edmonton, PO Box 1881, Edmonton, Alberta, Canada T5J 2P3. (403) 427-9416.

May 10-12

Northcon/83 and Mini/Micro-Northwest/83. Portland, OR. Contact: Electronic Conventions, Inc., Worldway Postal Center, PO Box 92275, Los Angeles, CA 90009. (800) 421-6816.

May 10-12

International Computer Show. Salon International de l'Ordinateur, Velodrome, Montreal, Canada. Contact: Jim Steinhart, Media Consultant, 559 Deloraine Ave., Toronto M5M 2C5. (416) 787-2138.

May 16-18

Electronic Components Conference. Orlando, FL. Contact: Electronic Industries Association, 2001 Eye St. NW, Washington, DC 20006.

May 16-19

NCC '83. National Computer Conference. Anaheim and Disneyland Hotel Convention Centers. Contact: American Federation of Information Processing Societies, Inc., 1815 N. Lynn St., Arlington, VA 22209. (703) 558-3612.

May 23-25

Computer Hardware Description Languages And Their Applications. Pittsburgh, PA. Sixth International Symposium. Contact: Takao Uehara, Information Processing Laboratory, Fujitsu Laboratories LTD., 1014 Kawasaki, Japan 211 or Mario Barbacci, Dept. of Computer Science, Carnegie-Mellon University, Pittsburgh, PA 15213.

Errata

The November *Digital Design* article entitled "Sorting Through The LAN Morass" was co-bylined "Ed Pevovar and Brian McGann" but was, in fact, written solely by Brian McGann. His complete company name and address should have read: *Associated Computer Consultants, Local Area Network Center, 2901 Park Ave., Soquel, CA 95073.*

Also, our January cover, illustrating the world of data communications, was produced by Racal-Milgo, Inc. (8600 N.W. 41st St., Miami, FL 33166) and not by sister-company Racal-Vadic, as indicated in the credit line.

Digital Design regrets the errors.

Save even more.

Effective immediately, System 2000 terminals are priced lower than ever before.

In quantities of 50, you can buy System 2000 black and white terminals for \$7,425.

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A new, improved way to give your competition headaches.

(System 2000 terminals, \$8,250*.)

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The combination of which will give you an edge if you're an OEM. In fact, quite a considerable edge.

And what will it give your competition? Something to keep them awake nights.

More OEM flexibility

There are five processor option slots in a System 2000 terminal. They'll allow you to add more serial ports, and more program memory (up to 1.28 megabytes).

A detachable keyboard with integral joystick is standard with pre-programmed peripheral interfaces.

User code may be downloaded to augment the system's capabilities, off-load the host CPU, and increase system response time.

Low price. High performance. And a whole new bend in flexibility.

A new ergonomic policy

On the screen, there are four hardware assisted work spaces. Each with a set of functions that

you can call up with simple English commands.

These individual workspaces reduce the overall system cost by eliminating the need for a separate alphanumeric display and a menu space on the digitizer work surface.

This feature, plus the fact that the System 2000 has a multitasking operating system, contribute to two very important aspects of customer concern: Ease of learning and ease of use.

Improves Tektronix™ PLOT-10™ four ways

You can put the System 2000 in a PLOT-10 environment very simply. And very quickly, you can improve that environment.

The System 2000 will give you a 62.5% higher resolution on a 1280 by 1024 line screen.

In black and white, the System 2000 will give you steady, flicker-free graphics. At a refresh rate of 60 Hz.

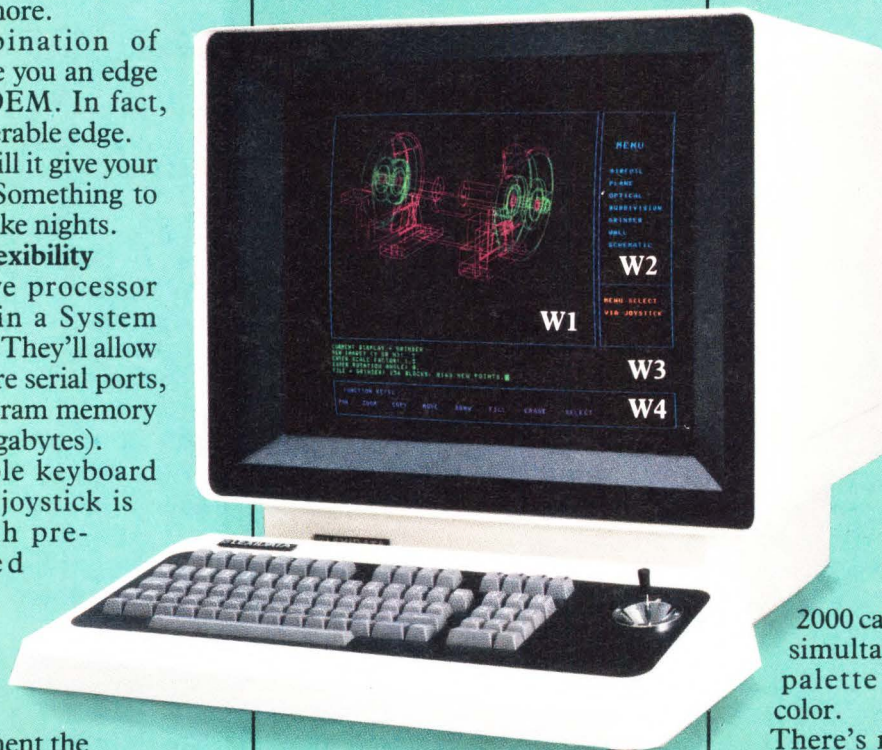
In color, the System 2000 can provide you with 16 simultaneous colors from a palette of 4096 shades of color.

There's more, too. Standard features like zoom, pan, text scroll and independently controlled cursors. And options like an 11" x 11" data tablet and a hard copy interface.

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W3 Is perfect for processing text.

W4 Is used for logging messages or annotating keyboard function keys.

Note: Each workspace has graphics and text cursors and is adjustable in size.

*PLOT-10 is a registered trademark of TEKTRONIX

* System 2000, black and white model, \$8250 in quantities of 50.

System 2000, color model, \$11,621 in quantities of 50.

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Write 16 on Reader Inquiry Card

News Update

"Japscam" On Hold

Current status of the 1982 "Japscam" incident involving Hitachi, Ltd., and others, trying to acquire IBM documents, has IBM on hold until the government resolves its criminal conspiracy charges. In a November 1982 agreement with Hitachi, IBM must wait 30 days after the government resolves charges before they may level their own civil charges. In return, Hitachi will turn any IBM documents over to the court to be placed under seal. According to a company spokesperson, "The principal goal of IBM is to get back the misappropriated material and to prevent it, or knowledge gained from it, from being used by these companies in the future." In a separate agreement, National Advanced Systems (a div. of National Semiconductor) will return any documents they may have directly to IBM. The government still has charges filed against Mitsubishi; IBM has not. According to the spokesperson, IBM is confident Mitsubishi did not have any of their material.

Games Company Enters PC Field

The Milton Bradley Company and Texas Instruments have announced a development which will make voice recognition and voice synthesis available for the TI-99/4A Home Computer. Milton Bradley will develop a plug-in peripheral device and software cartridges which include video games for all ages, as well as fun and learning cartridges for children. This is the first product of this type Milton Bradley has produced. In this non-exclusive agreement with TI, Milton Bradley has the right to apply the hardware and technology to identical products if so desired; however, TI has a 12 month exclusive on the software. Charles Perrottet, VP of Corporate Development for Milton Bradley, would not go into any details of possible future products for other home computers but said they have "no other announcements at this time."

Harris Reports \$2.6 Million Sale

Harris Corporation, Digital Telephone Systems Division today announced receipt of a \$2.6 million order for Harris 110 PBXs from the Ministry of Communications of Nigeria.

Questions arise over the possible sale of the Harris Telephone Division by the parent corporation and over the ability of the Nigerian Ministry to provide payment for such a contract. Imports of most goods have ceased under recent restrictions due to a hard currency shortage.

HP Forms Software Division

Hewlett-Packard Company has formed a new division called the Manufacturing Productivity Division. The new entity is part of HP's Business Computer Group and brings together four operations which had been part of either the Business Computer Group (BCG) or HP's Technical Computer Group (TCG).

The new division will focus on producing modular, distributed, networked software for planning, scheduling, monitoring, controlling and testing applications involving materials, processes, personnel or physical facilities.

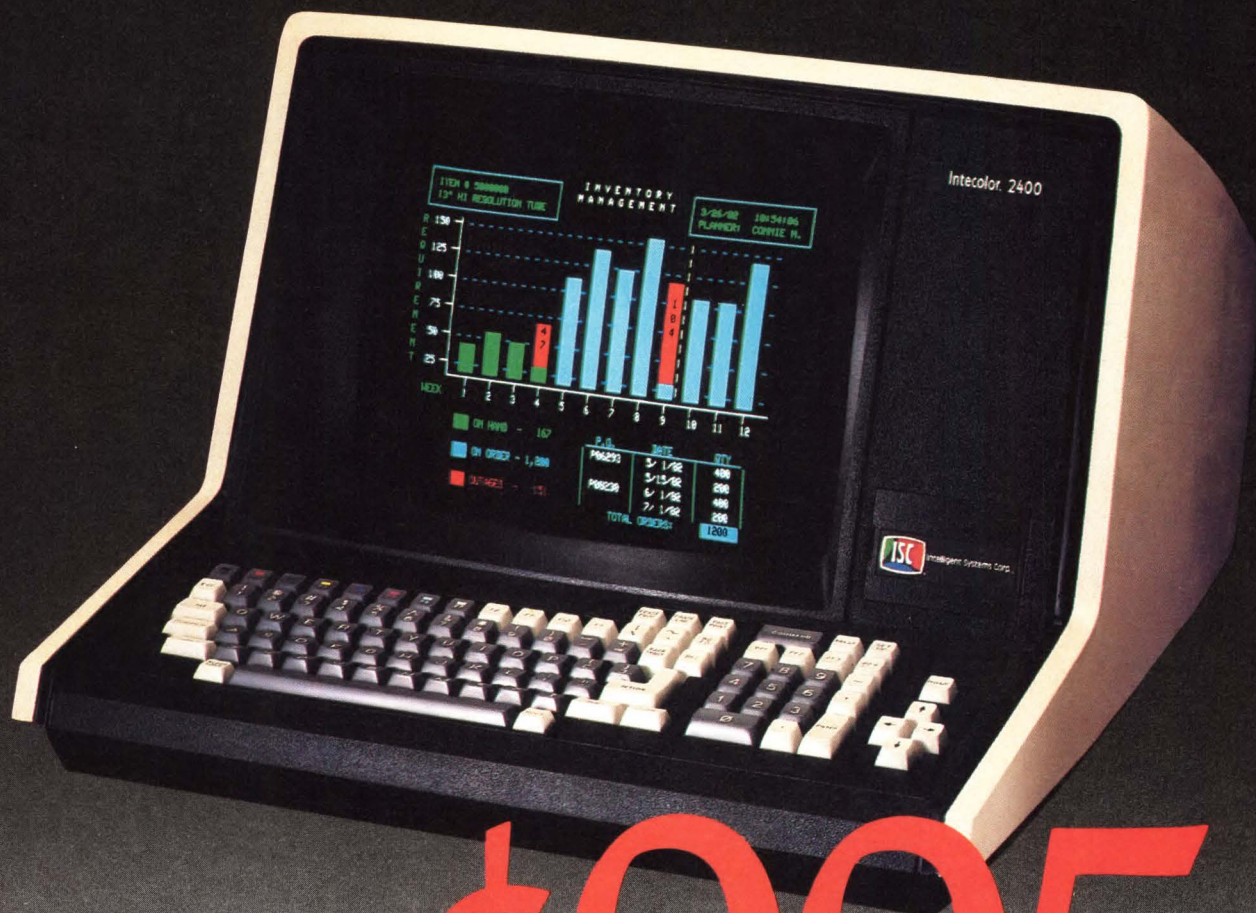
The new organization, "is to combine HP's abilities to serve the complete needs of a manufacturing facility—from the planning and scheduling of customer orders through the automation of production."

Ramtek Expands Move Into CAD/CAM

Ramtek Corporation has expanded its Software Affiliation Program by adding ten new vendor members whose CAD/CAM software packages will operate on the company's recently introduced RM-9460 and MARQUIS[®] graphics and imaging display systems.

The announcement follows the July signing of a joint marketing agreement between Ramtek and Digital Equipment Corp. under which Ramtek supplies its MARQUIS display to Digital for its VAX computer based system for CAD/CAM applications.

The program's new members and their respective offerings are MacNeil Schwendler (MSC/GRASP), Swanson Analysis (ANSYS), Georgia Tech (GTSTRUDL), University of Southern California (POST), GE-CAE (SUPER TAB), and GEOMOD, Manufacturing and Consulting Services (ANVIL-4000), Design Information Systems (DIS/ADLPIPE), Structural Programming, Inc. (MAPPS), PALETTE, University of California-Berkeley (SPICE, and KIC), and Silvar Lisco (GARDS/SDS, and CAL-MP).



Special offer. Immediate delivery.

The logical switch to color has never cost less. Now you can buy an Intecolor 2405 single evaluation unit at the 100-piece price of \$995 (U.S. domestic only). You get the advantage of vector graphics on an 80 column by 24 line screen, without sacrificing the most important capabilities you want from a VT100 terminal. Plus, the 2405's vibrant color conveys more information, more quickly and with greater comprehension than monochrome.

ANSI X3.64 system compatibility. The 2405 is the ideal replacement or add-on terminal. Highly compatible with VT100 and numerous other ANSI X3.64 terminals, the 2405 is easily integrated into any ANSI X3.64 environment. It also includes ASCII codes and a VT52 mode.

With all the features you need. Eight foreground and eight background colors. Terminal based

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do, we're confident that you'll enthusiastically agree with the growing number of OEMs and users who are making it dramatically clear that, "The future belongs to color!"

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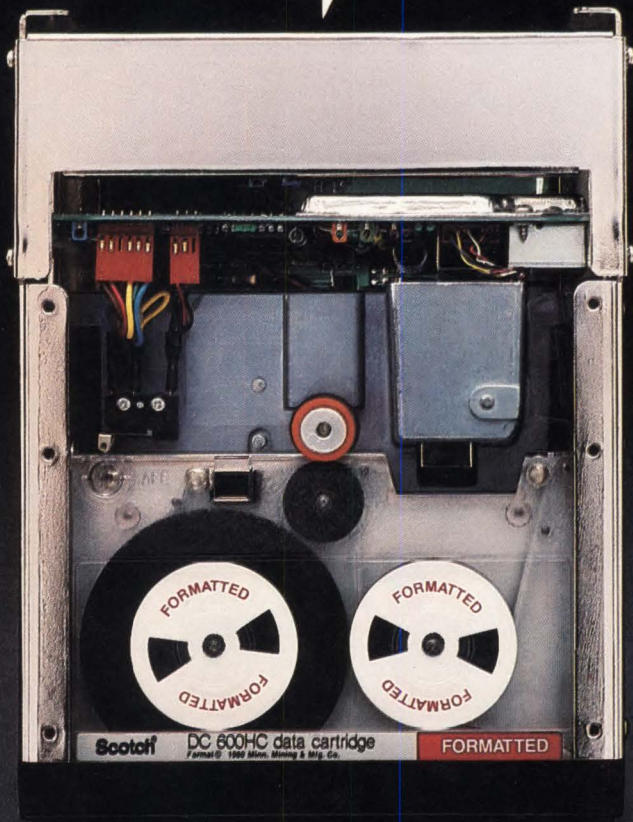
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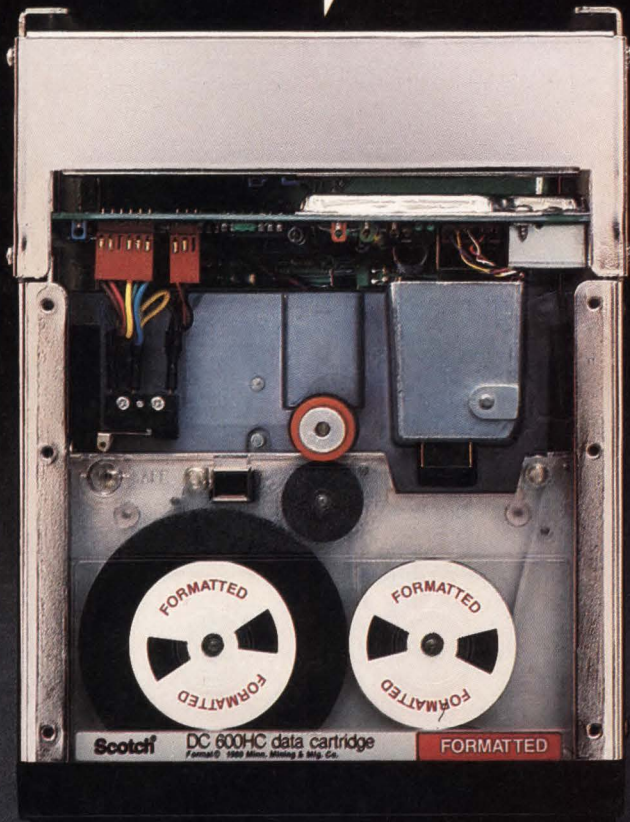
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Our ANSI X3.64 terminal has all the VT100 features you'll ever need in a conversational terminal. Plus color and vector graphics.

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Meet the high capacity $\frac{1}{4}$ " cartridge back-up system with the split personality. The 3M HCD-75 does everything streamers do, and more! Now you don't have to choose between streaming and block addressability for data storage. The HCD-75 lets you design a reliable system that does both. Best of all, it's available right now — thousands of them are already in use — with the following high performance features:

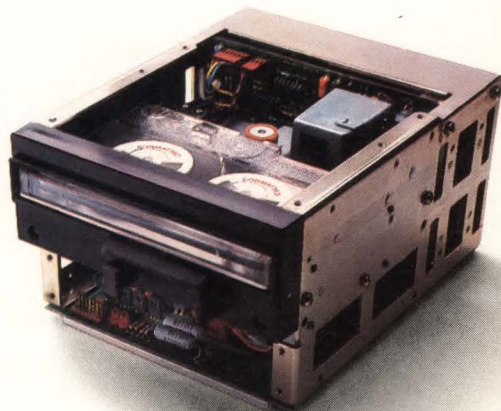
HIGH CAPACITY — a full 67 megabytes of formatted back-up storage — more than any other $\frac{1}{4}$ " system and most $\frac{1}{2}$ " systems.

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will read every 3M formatted data cartridge, no matter where it originated. A unique combination of stepper head and edge seek features allows unlimited cartridge interchange between drive systems.

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News Update

GE Announces 1.2 Micron Circuits Development

GE scientists announced today the successful fabrication of experimental microelectronic circuits with 1.2-micron geometries with a CMOS process.

The circuits were produced at GE's Research and Development Center in Schenectady, N.Y.

The company's integrated circuit-manufacturing subsidiary Intersil Inc. expects to be mass producing 1.2-micron CMOS circuits for GE's own products and its merchant market by 1985.

Initial applications will be in aerospace products but GE eventually plans to incorporate (AVLSI) in industrial robots and other automated factory equipment.

GE spokespeople note that CMOS circuits are ideal for harsh environments because they consume less power and have higher immunity to noise than other technology approaches (e.g., NMOS and bipolar).

IBM Uses E-Beam to Produce ROM Chips

IBM has announced the first large-scale production use of automated electron-beam tools to customize bipolar read-only memory chips. These ROMs are used in IBM's most powerful processors—the 3081, 3083 and 3084. Engineers from IBM's General Technology Division East Fishkill Facility, Hopewell Junction, N.Y., disclosed details of the ROM chip development and manufacturing process at Nepcon Northwest '82 at the San Jose Calif. Civic Center.

The photolithographic step is now eliminated by the electron-beam tool which directs a stream of electrons onto the ROM chip to interconnect preformed cells, or bit patterns.

The process increases productivity by providing faster design and engineering change turnaround, allowing engineers to fabricate ROM designs in as little as 20 working days.

OCLC Database To Be Copyrighted

Despite earlier indications that third party use of its vast data bases would be acceptable, the OCLC Board of Trustees authorized the registrations of the OCLC database

under federal copyright law. Copyright will be one tool in a broad, educational program being undertaken by OCLC and its members to ensure integrity of the data base.

Beginning in December 1982, copyright notices appeared with the log-on message on various OCLC products.

Under federal copyright law, databases are equally entitled to copyright protection whether printed in hard copy form or fixed in an electromagnetic medium. Many have considered the enforcement of copyright impossible because of the ability of users and third parties to capture positions of the database on their own computer. The move may indicate the willingness of this utility to support litigation against misuse of its data.

H-P Signs Ungermann-Bass for Ethernet Products

H-Ps Roseville Division will act as the company's coordinator for network products to be used with HP's new HP9000 Series of 32-bit computers.

William Ray, Engineering manager of the HP division, states that "HP supports Ungermann-Bass's strong commitment to networking standards. We were also sold by the present availability of the products." Many others have been announced Ungermann-Bass has been delivering vendor-independent local area network systems since July 1980 and is said to have supplied the first such products on the market.

Micro Focus and Intel Sign Joint Agreement

Micro Focus will be Intel's main COBOL supplier for its entire line of 16- and 32-bit microprocessors under terms of an agreement signed by Micro Focus and Intel.

The Micro Focus Visual Programming Tools™, including ANIMATOR™ for interactive program analysis and debugging, and FORMS-2™ for source code generation of interactive screen formats, will be available from Intel with Level II COBOL™, which is certified at the highest level of implementation by the US government.

The Micro Focus software will be available to run under the XENIX™ operating system, Intel's RMX 86™ operating system, and will also run on Intel's development systems.

News Update

Japanese Semiconductor Producer— \$30 Million Plant in U.S.

Construction of a new \$30 million U.S. facility for S.E.H. America will begin in the first quarter of 1983 near Vancouver, WA.

S.E.H. America moved from San Jose, Calif., to Vancouver in 1980. Initial production runs of ingots and wafers were begun in June, 1981. The total workforce now numbers approximately 150 persons, and with expansion the workforce is projected to grow to 400.

S.E.H. America is a wholly-owned subsidiary of Shin-Etsu Handotai Co., Ltd of Tokyo—the largest producer of silicon semicon-

ductors in Japan. The company will supply 4", 5", and 6" wafers to US customers.

Gate Array Market Competition Increases

International Microcircuits Incorporated (IMI), a designer and manufacturer of CMOS gate arrays, has acquired a 6,000 square foot building, adjacent to its current headquarters, for use in testing and administration.

IMI is said to be the oldest and largest designer and manufacturer of digital gate arrays. The move may be in response to GE recent announcements regarding the CMOS gate Array Market.

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* Q-Bus is the registered trademark of Digital Equipment Corporation.

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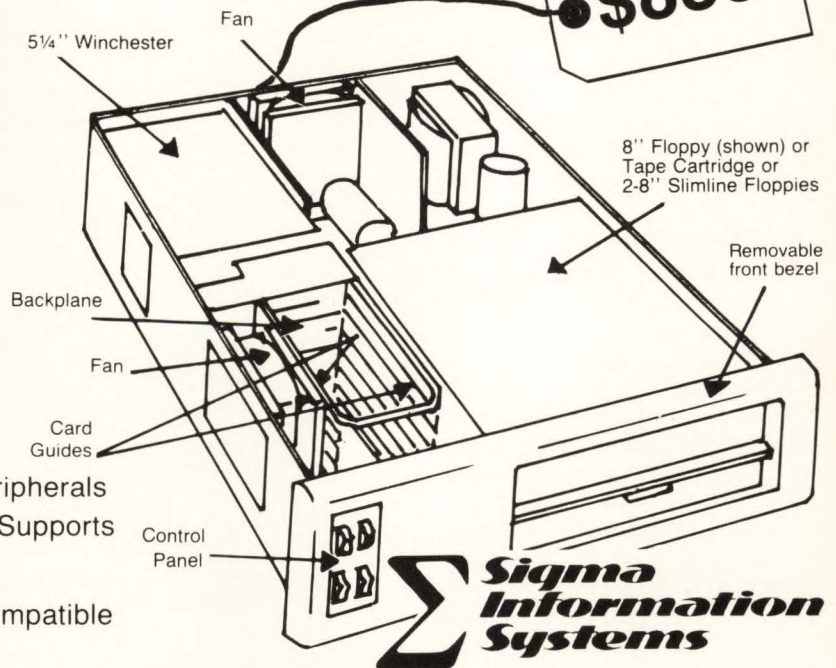
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A Glimpse Of The Factory Of The Future

In order to compete in today's aggressive disk drive market, many companies are investing heavily in advanced production technology. Shugart Associates (Sunnyvale, CA) has invested nearly \$18 million in production equipment in 1982. This equipment included three robots, a progressive assembly line for printed circuit board (PCB) insertion and three Class 100 clean rooms. This investment is expected to pay off in three seemingly disparate ways: automated drive assembly should be faster, cheaper, and of a higher quality than manual assembly.

The robots are in various stages of development in an engineering lab. At Shugart a robot is a single component in an integrated work cell that also includes a computer based controller, feeders, assembly jigs and fixtures, and sensors. The most completely developed of the three work cells has a PUMA robot arm and LSI/11 based controller. It is designed to build a base casting sub-assembly consisting of 8 components. Coincidentally, the controller uses a Shugart Minifloppy, a part it could help assemble easily calling forth science fiction images of robots cloning themselves.

The activity in a work cell is very intense. The single robot arm places a base casting on a press. It fetches a flange bearing and stakes it in place in the casting. Then the drive spindle and preload spring, plain bearing and drive pulley, and left and right diskette guide are assembled. The state of the work cell is monitored through almost 30 sensors. The operator is informed of any anomalies through a voice synthesizer. He will be told a feeder is empty, for example. The voice capability is an important feature in that it frees the operator from continually watching the work cell. He can instead occupy his time by running other robotic work cells, up to 6 in all. A single work cell should be able to complete the assembly in 76 secs.

Manual assembly takes about 2 minutes and requires 3 assemblers. Eventually the robots will be moved out of the lab and into a progressive assembly line.

The company is also installing a progressive PCB assembly line; not a surprising move for a company that makes a million circuit boards a year. This line uses Panasert insertion equipment from Panasonic. It is the longest line using this equipment in the US—136 ft. plus wave soldering and post soldering cleaning. The insertion equipment eliminates sequencing of ICs onto tape. It can rotate a board allowing ICs to be placed along X and Y axes. The

goal is to assemble and test an 8" PCB in less than 30 minutes.

The clean tunnels are used for Winchester assembly. Tunnels allow material to flow in a progressive line reducing handling and allowing repeated inspections. Problems that are found are corrected before the part moves on. One of the three tunnels is now operating. The "under the bubble" HAK component is assembled in this tunnel. This assembly includes the read/write head and arm of the SA600 5.25 Winnie. Parts flow through the tunnel in tubs on a conveyor to work stations where they are assembled and inspected. —Eidsmore

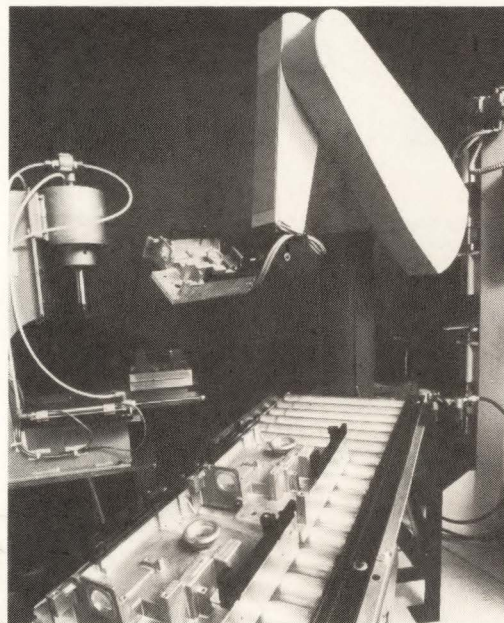
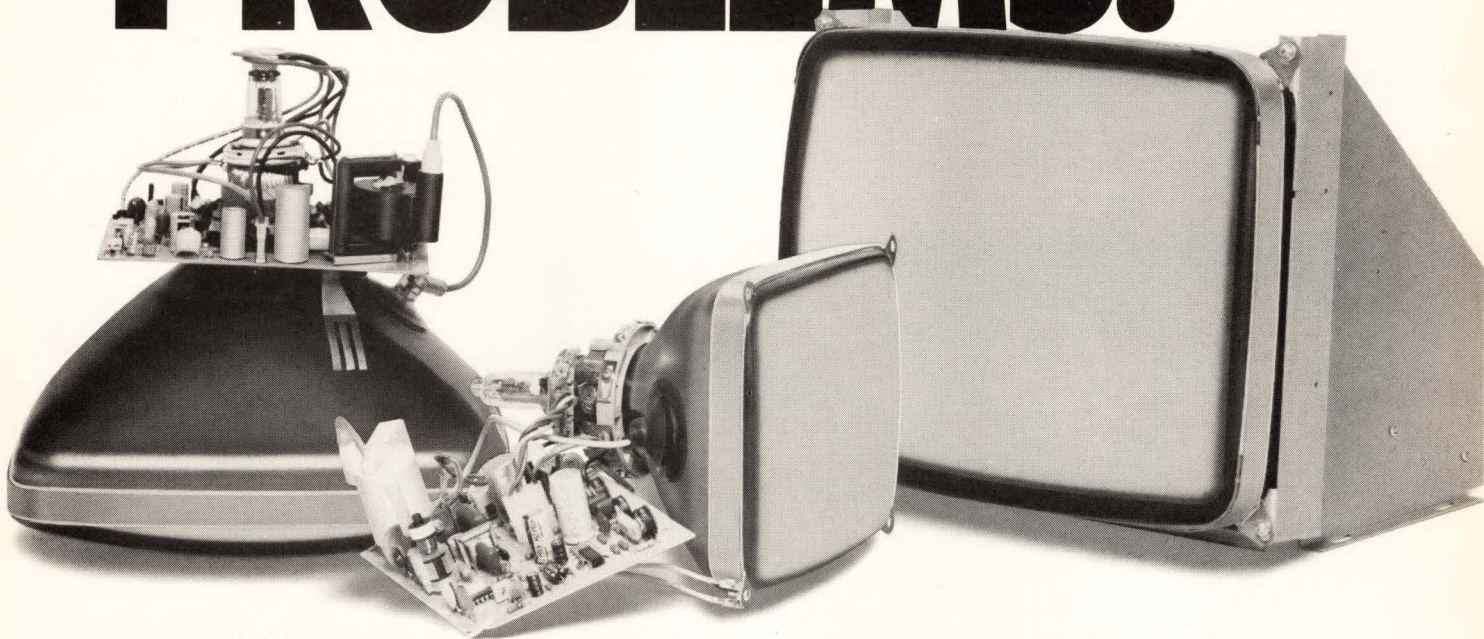


Figure 1: Robot arm moving base casting from feeder to press. Proximity sensors insure proper alignment.



Figure 2: Interior of Class 100 clean tunnel. Tunnel allows progressive manufacturing within controlled environment required by Winchesters.

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Logic Analyzer Offers New Flexibility

By using a design that combines dual timebase, on screen soft keys and ROM, RAM and COMM packs, the 1240 Logic Analyzer from the Design Automation Division of Tektronix, Inc. claims a new degree of flexibility and ease of use for stand-alone, mid-priced logic analyzers. Users can choose from four levels of operation (via a touch sensitive display) depending upon their familiarity with logic analyzers.

New features of the instrument include dual timebase which allows concurrent data acquisition from two different functional modules. It can analyze all the

interactions between these modules regardless of their timing relationships.

The incorporation of soft keys on a touch-sensitive display makes the instrument easy to use by the novice. Only the keys needed for a specific operation appear on the screen.

Another feature is ROM, RAM and COMM packs which tailor the 1240 for different work environments and applications. The packs look like Atari video cartridges and plug into a side slot. The ROM and RAM packs allow portability in that users can store their setups and plug them into

another machine. COMM packs adapt the instrument to different communications interfaces including RS-232 and GPIB (IEEE-488). Future COMM packs will be developed according to industry needs.

The 1240 mainframe accepts up to 4 data acquisition modules of two types: the 1240D1, with 9 channels and speeds up to 100 MHz; and the 1240D2, with 18 channels and speeds up to 50 MHz. Available this spring, configurations range from \$7500 to \$19,500.

Write 236
—Hawkins



Figure 1: Lisa, the new personal computer from Apple, will be a highly competitive contender for the office systems market.

Apple Aims At The Office

In making the long awaited announcement about its new Lisa computer, Apple Computer Inc. has demonstrated a well planned product directed at the business environment. The new system slightly resembles the much more expensive Xerox STAR, and incorporates an advanced (high level) software interface, a mouse for interaction with window based iconic menu functions, high resolution monochrome graphics (720×364), a Motorola 68000 processor, and a broad range of supporting software. The system also offers access to facilities and

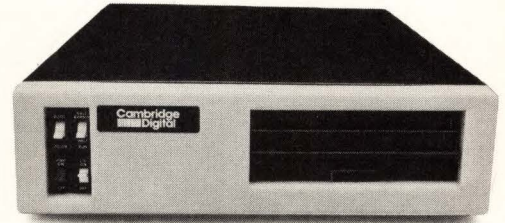
peripherals such as daisy wheel printers, hard disk drives, local area networking, diagnostics, videotex type databases, and DEC compatible systems. By keeping the price under \$10,000 the company has become a highly competitive contender for the high quality office systems market.

Concomitant announcements from Unisoft Systems Corporation, Science Management Corporation and Microsoft will provide Unix operating systems and a Basic Interpreter for the computer. Other software announcements are likely to follow.

LISA, which stands for Local Integrated Software Architecture, represents a \$50 million investment in research and development since 1979. The six key software applications packages developed include an electronic spreadsheet, a word processor, graphics, graphing (business charts), data base manager, and an analytic project manager. Combined with the screen based iconic menu operation, all of the software packages are inter-operable, allowing the transfer of information or graphics between files for merging or calculation. Lisa will also run BASIC, PASCAL, and COBOL, and supports the CP/M family and Xenix operating systems.

Another feature that will enhance use of this system is its ability to emulate DEC VT100 and VT52 terminals. Lisa can also communicate with any IBM or IBM compatible system supporting 3270 bisynchronous protocols. The company claims that users may learn to operate the system in under 30 minutes. —Borrell

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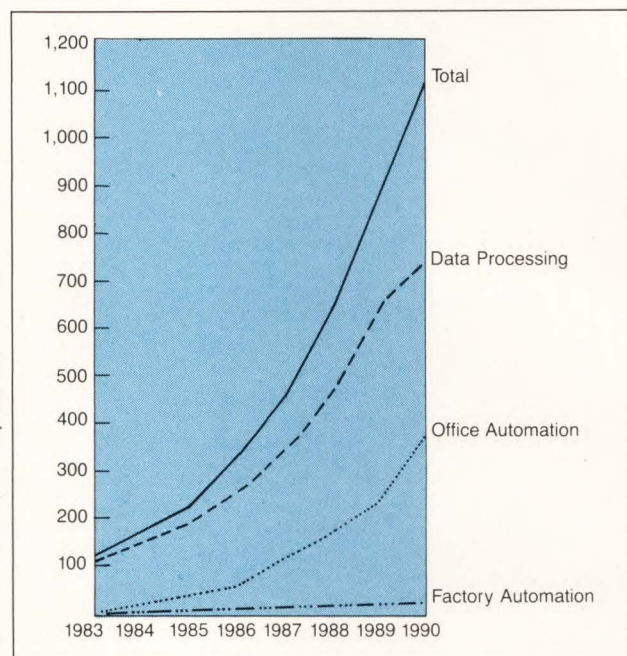
Technology Battle Seen In Growing LAN Industry

The local area network industry is heading into a phase where competitive advantages will be attained on a basis of system performance. The competitive issue will not be decided by the type of devices which a network interfaces; local area networks will be expected to accommodate to the users' requirements.

Users will wait for the dust to settle before making their decisions regarding local area networks. In 1983, however, substantial shipments of local area networks will begin. VDC predicts industry shipments of 136,000 nodes in 1983, where a node refers to a cluster of peripherals such as 8 terminals, 8 microcomputers or one computer. Shipments are forecast to increase to 1,175,000 nodes in 1990. The bulk of local area network shipments in 1983 will be for data processing applications; 95.3% of the networks will be primarily for these high performance systems. The proportion will decline to 73.6% by 1990.

Total market growth will approximate 36% annually from 1983 to 1990 in number of nodes. In dollars, the annual rate of in-

Figure 1: Local area network shipments from 1983-1990 (thousands of nodes).



crease will be 32%, as unit prices decline somewhat over this time period.

Many small companies are now in the local area network business, and there is bound to be a shakeout. Starting in 1983, the price of entry into the market will increase sharply. Future entrants

will be large, well-funded companies.

Further information regarding this report, "Local Area Networks: A Strategic Analysis 1981-1990," can be obtained from Venture Development Corp., One Washington St., Wellesley, MA 02181; (617) 237-5080.

Superminicomputer Shipments Escalate Rapidly

Shipments of superminicomputers will grow at a compounded annual rate of 31.9% from \$1.2 billion in 1981 to \$4.8 billion in 1986, according to a recent study by VDC.

The term "superminicomputer" has been used to describe a great variety of computer systems; its usage has sometimes become quite vague. The VDC definition of a superminicomputer is: the CPU has an internal word length of 24, 32, or 48 bits; the maximum main memory capacity is 1 Mbyte or more; the logical address space is 1 Mbyte or more;

the maximum program size is 1 Mbyte or more; and the system uses a "bus" structure rather than the point-to-point structure typical of mainframes.

The first true 32-bit superminicomputers were introduced by Perkin-Elmer and Gould/Systems Engineering Laboratories in 1975 (although the Harris SLASH Series dates from 1973). Although these were the first minicomputers to use 32-bit data paths, IBM mainframes had been using them for many years. Early minicomputers were used in process control and other industrial applica-

tions. Early superminicomputers were designed to handle heavy computational and data analysis applications, as well as fast real-time and large data acquisition projects.

Not until Digital Equipment Corporation entered the market in 1978 with its VAX 11/780 did the market explode. With 8 Mbytes of main storage and 4 Gbytes of logical address space, the potential for a whole new realm of applications was realized. CAD/CAM systems in particular thrive on the 32-bit system architecture.

Here's a smart addition to our family of intelligent plotters.

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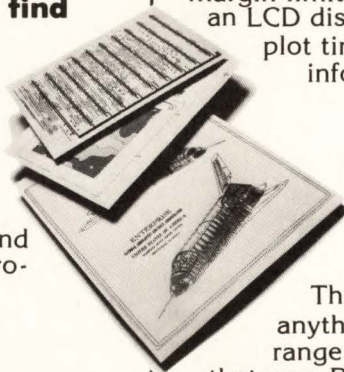
A high-performance plotter with a remarkably low price tag.

Our newest model, a four-pen, 36-inch intelligent plotter, is just as smart as the rest of our line — we've just made it more affordable. To do so we had to sacrifice a little speed and resolution.

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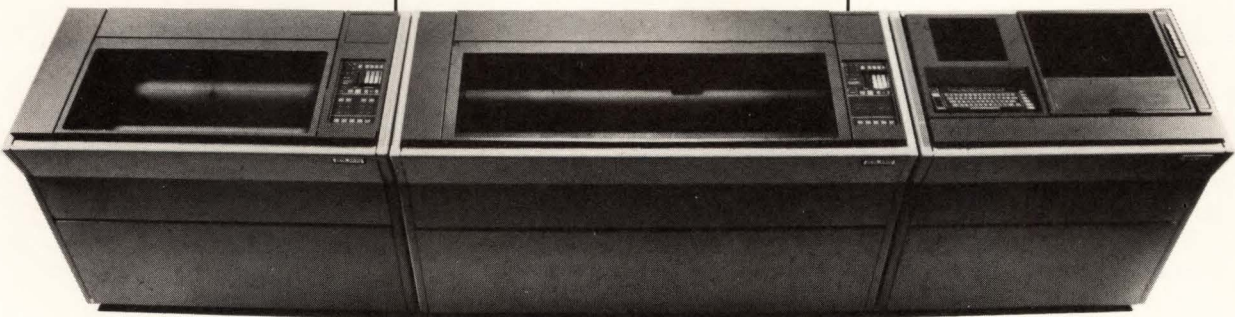
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Zeta C63 Intelligent Plotter

Complete workstation with read/write tape drive, built-in CRT and keyboard and plotter controller.

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Early superminicomputers concentrated on the sophisticated scientific end user and OEM/system houses. Prime Computer, however, focused almost exclusively on the end user and the general purpose business environment. First shipping their 350 model in 1978, Prime signaled their intention to devote themselves entirely to the 32-bit systems. Other vendors have since seen the need for business systems and have targeted their superminicomputer systems to this market segment.

The industry has been dominated by six vendors who have shaped the definition of the market segments. These market areas are real-time, computational, timesharing, and general purpose business systems. The first two areas have provided the main impetus for the development and adoption of superminicomputers. The last area has only recently turned to superminicomputers for high performance at lower costs.

Real-time computer systems are designed to react to external stimulation or demands very quickly, in "real time," as their name implies. These systems are used in time critical applications, where data acquisition, processing, and action decisions are all integral parts.

Computational superminicomputer applications are noted for their large program size, large volume of data, and intensive "number crunching" capability. The computational superminicom-

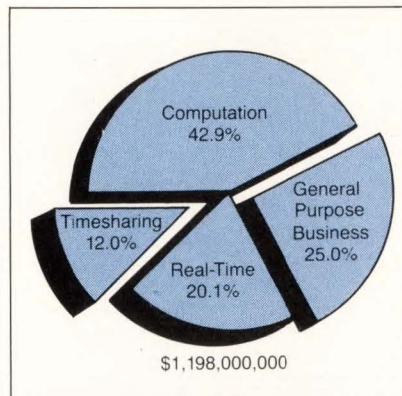


Figure 1: 1981 market share of superminicomputers by application area in percent of dollars.

puter plays its most important role in the processing of data rather than in the acquisition or outputting of the data. Computational applications are most commonly found in scientific or engineering laboratories, where complex algorithms are used to manipulate the raw data.

Timesharing systems are used primarily for their capabilities to support large numbers of simultaneous users. Often the superminicomputer is used to upgrade from a 16-bit minicomputer system. Obviously, mainframes are not price competitive for strictly timesharing applications.

General purpose business systems are used for exactly what their name implies: for business purposes, rather than technical or scientific applications. Superminicomputers were originally de-

signed for scientific uses. However, it has been found that minicomputers and superminicomputers can be used to advantage in many business environments.

The growth rate figures for the superminicomputer market are quite high, even for the fast growing electronics industry. There are several reasons for this. First, many new vendors are expected to enter the superminicomputer industry during the next five years. Any minicomputer or microcomputer vendor is a potential superminicomputer competitor. Second, existing vendors of 32-bit systems are sure to expand their product lines both up and down the performance spectrum. Superminicomputer systems will become the backbone of many computer vendors' offerings. Third, prices will be falling dramatically.

The appearance of low-cost superminicomputers, perhaps incorporating 32-bit μ Ps, is anticipated during the next several years. These low-cost systems will prove quite popular, from laboratory instrumentation and data acquisition applications, to small business computers. The low-cost systems will contribute to the quickly declining average selling price of superminicomputers.

Further information regarding this report, "The Superminicomputer Industry 1981-1986: A Strategic Analysis," can be obtained from *Venture Development Corp.*, One Washington St., Wellesley, MA 02181; (617) 237-5080.

Computer Graphics Market To Top \$17 Billion By 1987

Technology advances, cost effectiveness, and sharply heightened demand will fuel overall market growth of computer graphics at a compound annual rate of 41.6% through 1987, when sales will top \$17 billion.

Trends and developments continue to spark major changes in industry structure and the competitive environment. More diverse applications and new mar-

ket niches are on the horizon as competition moves rapidly toward a strong focus on applications rather than technology. CAD/CAM will be the fastest growing application, and a new low-end CAD/CAM market holds great promise in the 80s.

The choice of display technology has changed dramatically. Raster technology has become the leader in displays and is expected

to continue gaining over the other display technologies. The raster non-image processing displays/systems segment will see the sharpest growth, with sales increasing at a compound annual rate of over 60% through 1987.

The market for hardcopy devices is holding relatively steady but may show a resurgence of growth when color electrostatic printer/plotters become available

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RM02/RM05/RP06 media compatibility—interfaces PDP-11/04 through 11/60 computers with up to four Winchester, or CDC9762/9766 equivalent disc drives employing

industry standard SMD interface, as well as Memorex 677/RP06 type drives—includes three sector buffering, 32-bit ECC and dual port capability.

MAGNETIC TAPE CONTROLLERS

These 1/2" mag tape controllers/couplers handle standard start-stop and streaming drives with TM-11 or TS-11 emulations.

1/2" **STREAMING/START-STOP COMPATIBLE**—Model DU130—Handles up to eight 9-track, 800/1600 BPI industry standard drives at 12.5 ips to 125 ips—interfaces dual density (NRZI/PE) drives from all manufacturers. TM-11 emulation.

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within the next 18 months. Electrostatic devices are likely to displace some portion of the pen plotter market, although 10-pen plotters are currently in the design stages.

Other hardcopy devices — such as camera systems, ink-jet technology, laser photocopy, and small CRT copiers — are expected to make significant gains as users demand better quality, lower prices, and new uses. According to the report, these hardcopy devices may increase the growth rate of the overall hardcopy segment within the year.

Turnkey systems houses are the

cornerstone of the computer graphics industry, providing complete systems as well as software and services, and continue to experience extremely fast growth due to their inherently integrative nature. Competitors now range from start-up companies that specialize in one graphics product, to huge conglomerates that have been drawn by the tremendous market potential.

The variations are emerging — from turnkey systems to time-shared databases; from specialized hardcopy services to retrofits which add graphics capabilities. As competition intensifies, suc-

cessful market penetration will depend upon a myriad of factors; the primary trends are toward raster technology, color, applications software, 32-bit technology, and good-quality hard copy.

Japanese competition is rapidly increasing and may soon pose a formidable threat. The 4% current Japanese share of the US market could increase to 30% by 1987, with a possible 80% Japanese market share by the end of the decade.

For further information contact *Creative Strategies International*, 4340 Stevens Creek Blvd., San Jose, CA 95129, (408) 249-7550.

Computer Industry's First World Marketcenter

BOSCOM, the first permanent international computer and communications marketcenter, is expected to attract over one million buyers of computer information equipment per year when it opens its doors in mid-1984. Part of a billion dollar, 100-acre development along Boston's Commonwealth Pier, BOSCOM has the potential to become a total resource center for OEMs, resellers and systems integrators. According to G. Daniel Prigmore, President of FMR Properties (a subsidiary of the Fidelity Group and developer of the project), "A marketcenter must provide the space to accommodate the entire industry, allowing its buyers to become fully informed about available products and services by travelling to a single location as an alternative to having to travel to multiple trade shows, seminars and individual vendor sites."

The 1.4-million-square-foot marketcenter will comprise 615,000 sq. ft. of permanent showrooms on three levels; 300,000 sq. ft. of temporary exhibition space to accommodate conventions and trade shows; eight lecture halls and rooms for meetings and seminars of all sizes; hospitality services; a press and communications

center with information database retrieval, electronic mail, word and data processing, telecommunications, Telex and facsimile services; and international video-conferencing facilities.

BOSCOM has commitments

*A marketcenter
must accommodate
the entire industry,
allowing buyers to
become fully
informed about
available products
and services.*

from over 60 major companies that will maintain permanent showrooms including IBM, Burroughs, Western Union, Philips, and France Telecom. In addition, along with BOSCOM planned programs, eight major industry and management associations

have committed to holding annual conferences at BOSCOM. In all, over 400 events are planned each year. "We have formed a BOSCOM Program Company to develop the continuous weekly events that will focus on the users of the industry's products and services according to management function or industry orientation. The buyers will be drawn to BOSCOM as affinity groups, creating an application oriented environment meaningful for both buyers and sellers," Prigmore said.

John Cochran, BOSCOM's Director of Marketing, feels that this type of marketcenter may one day replace many of the travelling shows and that four or five major cities throughout the country have the potential to support this type of center.

BOSCOM has run into some difficulties, however, involving the construction of its hotel and restaurant facilities. According to a recent report in the *Boston Ledger*, construction of these facilities conflicts with other development projects that are planned for the area. As it stands, there will be hotel accommodations available in the area but their size has yet to be determined.

—Hawkins

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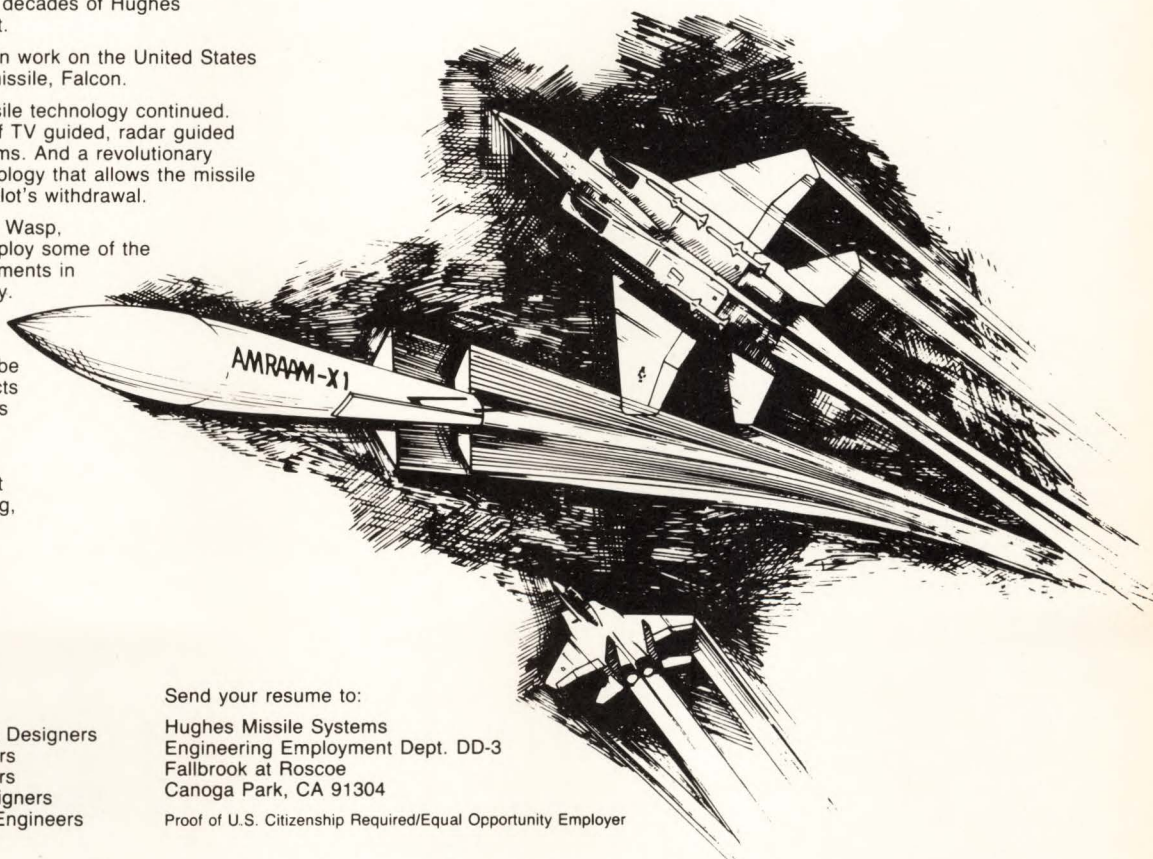
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In many applications, program stepping functions are performed by counting M_1 states by means of a timer/counter. The timer is loaded to generate an interrupt after each program step. The step handling subroutine displays the contents of various registers, waits for a new command such as a new step and the cycle is repeated. In the case of the 8080 and 8085, everything is all right until the step function is performed without interfering with DMA (i.e. an A/N display using DMA for screen refreshing).

In this case, if the DMA is performed in burst mode the processor occasionally fails to recognize the interrupt after each step. In non-burst mode it may miss several steps.

The explanation of the phenomenon could be found in the flow chart of the μP . Having finished the DMA cycle, the 8080 begins a new T_1 state without checking if the instruction is over, or if an interrupt is pending. So the internal INT FF will not be set. The system will not react to a pending interrupt. If the DMA occurs often, i.e. it is done in non-burst mode, it is possible to perform several M_1 cycles until the system observes the interrupt, due to the random timing of the HOLD request. If the μP had been constructed according to the modified flow chart (dotted line—"needed way") it wouldn't have had any critical conflicts between DMA and the interrupt acknowledgement. This problem could appear in some real time programming applications, and could be solved by inverting the priorities of the DMA and the interrupt during the step in the program. In fact, it would be enough to disable the DMA request only in the T_2 of the instruction, but there is no hardware criterion for such solution (except redesigning the 8080). So the DMA request has to be disabled during a whole instruction execution time, in full knowledge of all the disadvan-

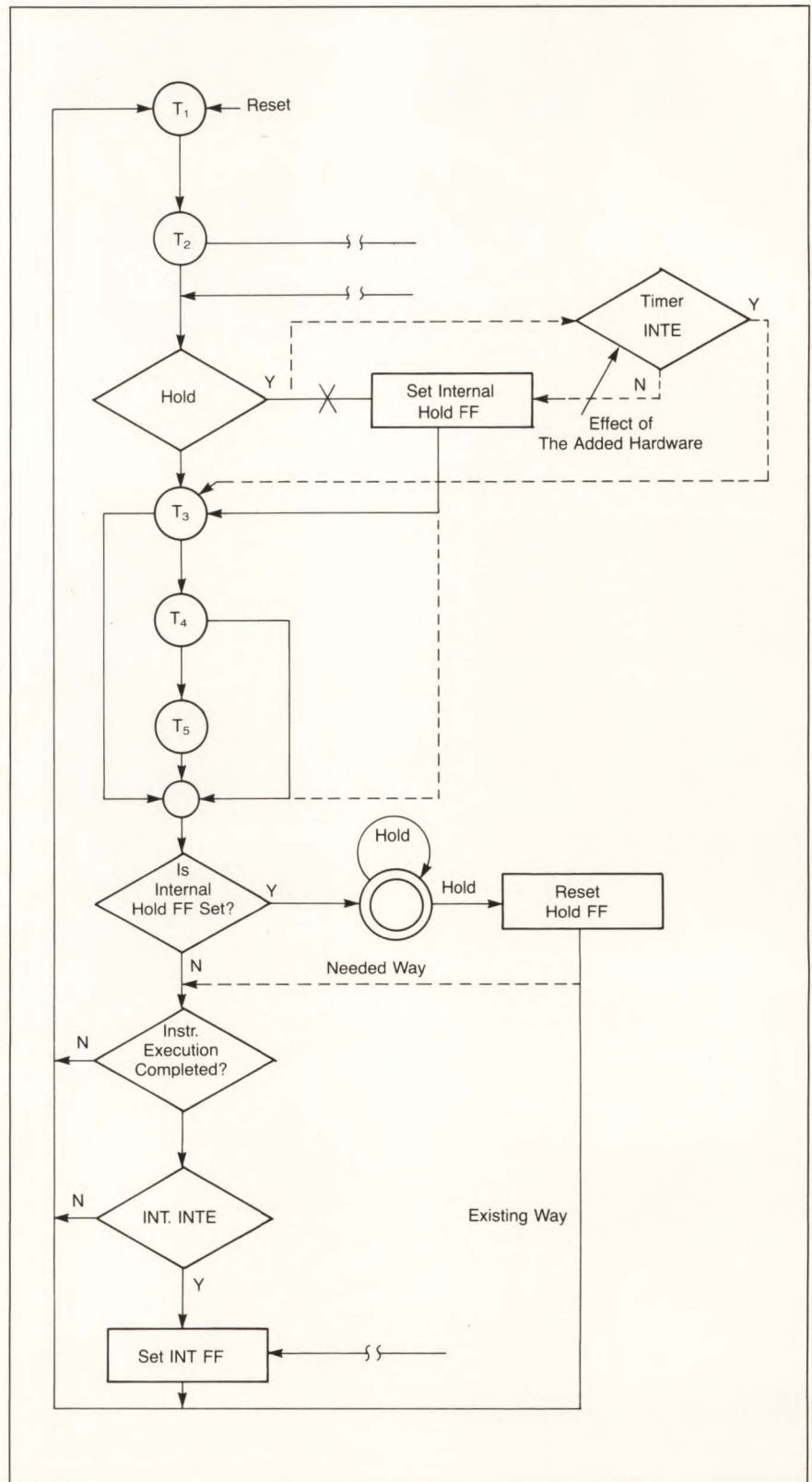


Figure 1: The effect of added hardware.

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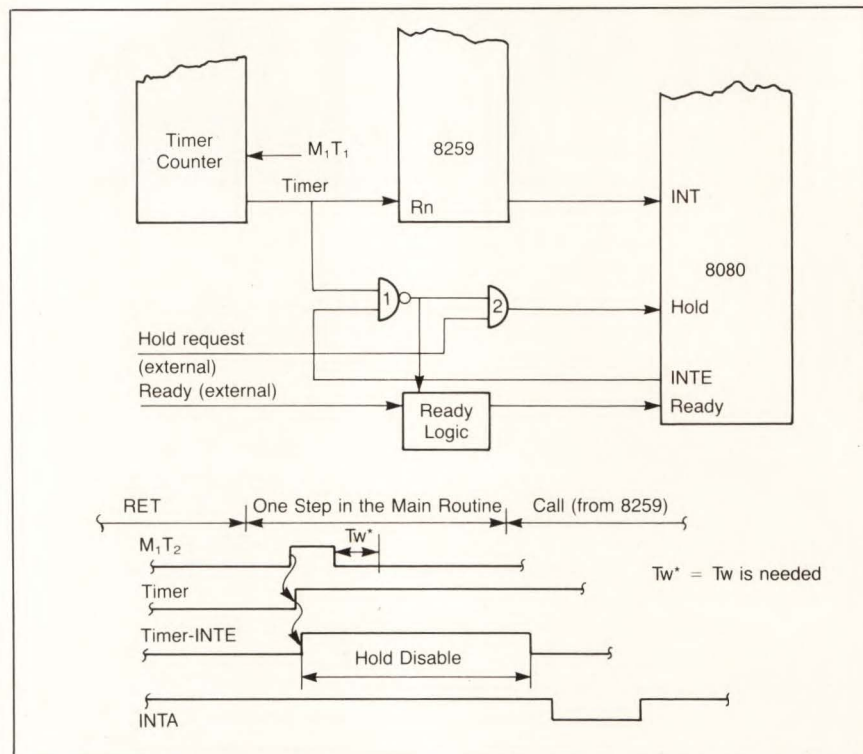


Figure 2: A possible hardware solution.

tages concerning the DMA operations. A possible hardware solution is presented in **Figure 2**.

When the timer is depleted the recognition of the HOLD request is inhibited for the period of the instruction execution time by the gates No₁ and No₂. This excludes all possible conflicts because the "TIMER" signal may appear only following an M₁T₁ (no DMA). When the μ P observes the interrupt and INTE goes low, a HOLD request will be observed (gate 2 is enabled by gate 1).

The DMA will be performed during the step handling subroutine, and the danger of multi-step

is avoided. For proper functioning, during the step, a T_w state should be included (Ready logic box). The effect of added hardware is shown in **Figure 1**.

The presented solution has limits and disadvantages. The HOLD request for example in the worst case, would wait for a whole instruction execution time, including the states T_w. Careful consideration should be made of all aspects of system design before applying solutions.

István Szikszai, Hungarian Academy of Sciences, Computer and Automation Institute, Hungary, H-1131, Victor Hugó u. 18-22

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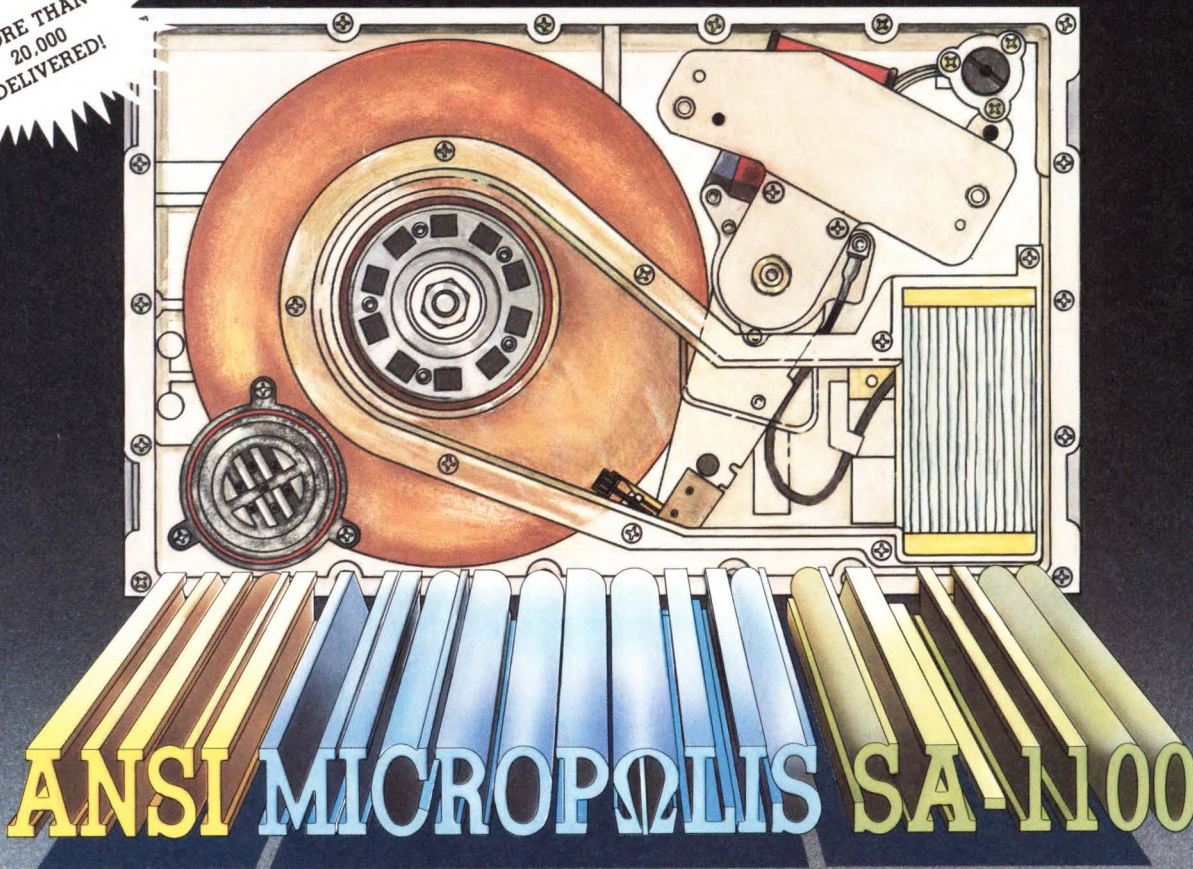
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The Automation Evolution

Computer integrated manufacturing is essential to the success of the industry.

by James A. Baker



Jim Baker joined General Electric in 1952 after graduating from Southern Methodist University with a BSEE degree.

During the 1950s and 1960s, he held a series of engineering and sales assignments in the Company's industrial heating, apparatus service and numerical control businesses.

He was named General Manager-Industrial Control Products Department in 1970, and then moved to Cleveland in 1973 as General Manager of the Lamp Products Operation.

Jim was elected a Company Vice President in 1977 and later became Group Executive of the Lighting Business Group.

He left Nela Park in 1979 to take over the Industrial Products and Components Sector, where he immediately reoriented that Sector toward electronics and the rejuvenation of industrial electronic businesses aimed at serving the factory automation market.

Baker now heads the Technical Systems Sector, which includes electronic components, medical systems, aerospace, mobile communications, electric motors, and industrial electronics businesses. His management strategy is to make GE the leading worldwide supplier of high-technology and industrial automation equipment.

Some business leaders think the industrial base of the U.S. is going through a period of adjustment; others think we are collective victims of an industrial malaise.

Regardless of who is right, U.S. production is too low, manufacturing technologies are too old, and too often we are guilty of turning out products which customers increasingly regard as high in price and low in quality.

In recent years, we've sat back and watched foreign competitors take U.S. technology, improve on it, and toss it back with devastating effect. As a result, American industry today faces three choices: automate, emigrate or evaporate.

Automation holds the key to enabling U.S. industry to regenerate itself—like a phoenix from the ashes—to achieve a competitive edge once again over foreign competitors. Automation is the answer to lagging productivity. It also puts quality in and takes the cost out of products.

Without automation, most American businesses have no future. Smart management today seems to realize this. They seem to sense that those who hunker down or hibernate during these tough times may never get up again. Yet, paradoxically, industry in general is slow to make the commitment to get on with automation. Certainly, there are some strange priorities at work when a nation automates its bowling alleys two decades before it gets around to doing the same for the primary generators of its economic livelihood.

Some industrial leaders feel they cannot afford to invest in automation in times of high interest rates. This is a "paper tiger." The capital is there, and so are the financial incentives. There is a significant tax credit for incre-

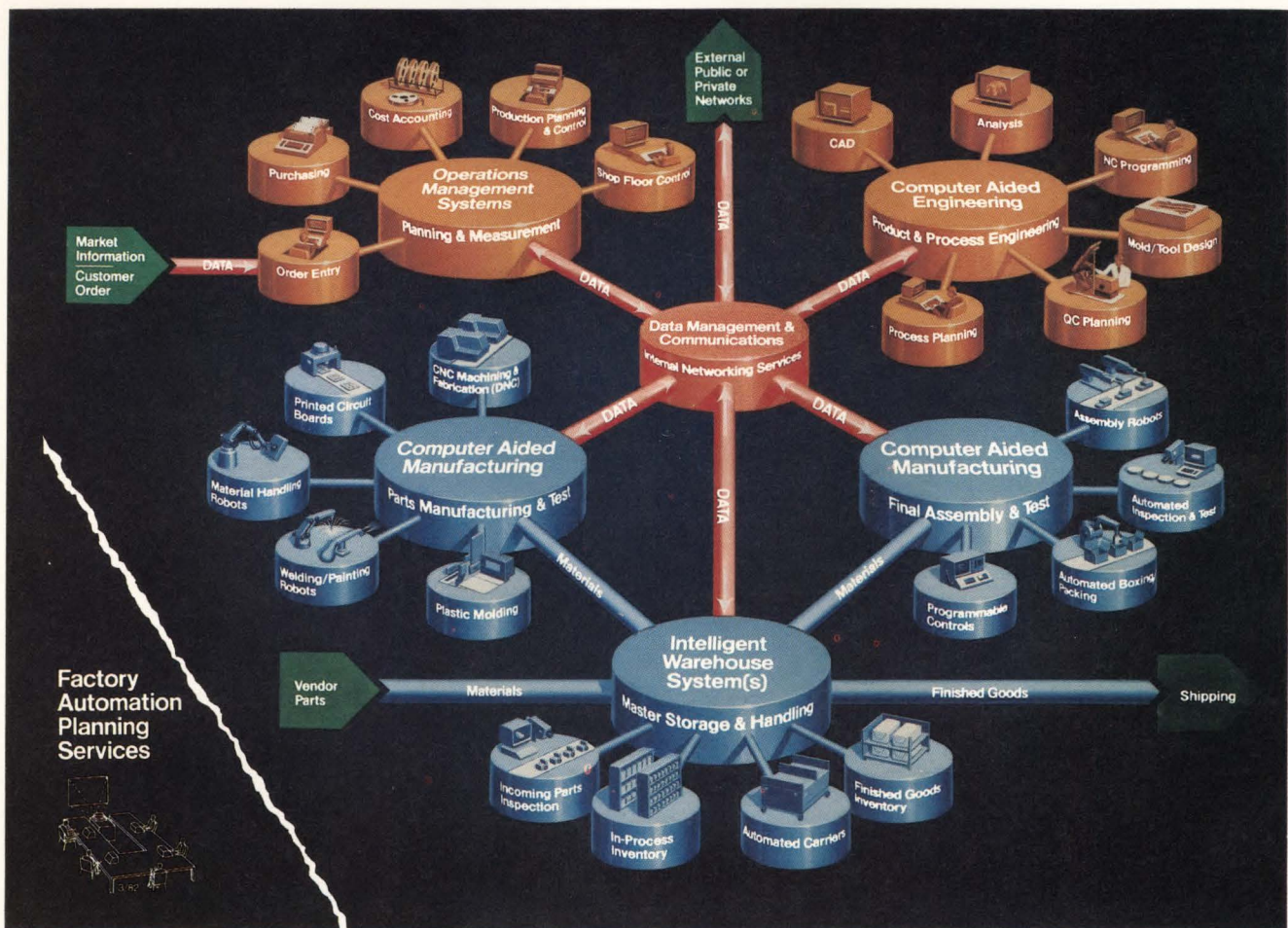


Figure 1: GE's Road Map to The Factory with a Future.

mental R&D, and additional credits for building rehabilitation, plus faster tax write-offs for new plants and equipment. Some managers worry about labor's resistance to automation. But labor and management seem to agree in principle that automation is preferable to a complete plant shutdown and permanent layoffs. Ten years ago a CEO of an automotive company wouldn't have been caught dead next to a robot in a TV commercial.

The most prevalent argument being used by top management for not automating is that automation's main contribution is increased capacity. And, the argument goes, why increase capacity when you can't sell all the products you can produce now.

Certainly it is true that addi-

tional capacity is no longer by itself a valid justification for new equipment. But you have to look at automation as it affects the bottom line. And today's bottom line is a reflection of the quality of your products, as well as your overall productivity.

Corporate managers have found that product quality, not to mention cost, is heavily tied to the degree of technology and automation in the plant, and that you cannot wait until bad times turn good and capacity increases substantially to invest. GE has put a billion dollars in the past two years into automating some of its aging factories—including more than \$300 million in a 75-year-old locomotive facility in anticipation of a substantial business upturn in the future. This level of invest-

ment is not considered a luxury, or a risky venture, but survival insurance.

Automation Evolution

Manufacturing managers are aware there are no easy or fast solutions. Automation will be evolutionary. It can start with a robot or NC controlled machine tool work station, grow to larger islands of automation, expand to complete cells of automation and eventually become an integrated system.

GE has spent another half billion dollars assembling a complete array of industrial automation products in order to facilitate automation of customers' plants. Both large and small customers have been asking: How much automation do I need? Where do

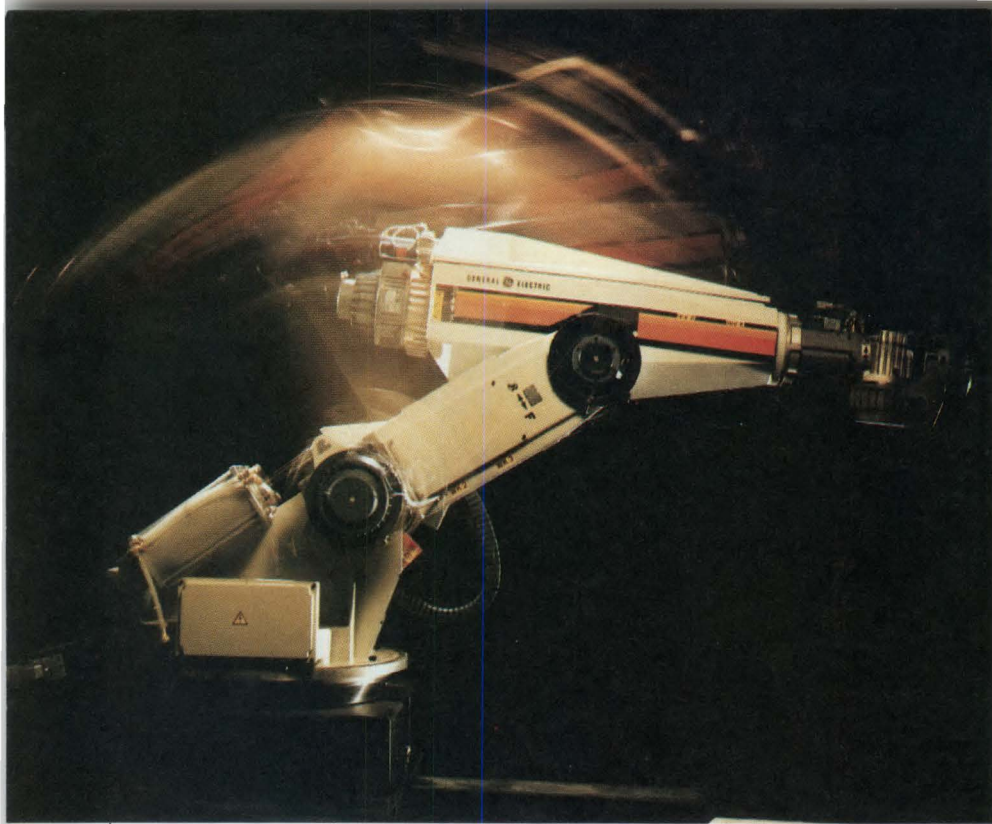


Figure 2: Robots' speed, precision and repeatability lead to higher quality, lower cost products.

I start? To answer these questions, GE formed a Factory Automation Planning Service to help customers identify their greatest productivity opportunities, and then to work with their management to propose a program which will take into account volume needs, resources, competition, need for standardization and flexibility, and a host of other factors.

Because factory automation can be as mysterious as ESP, a team of GE people devised the "Road Map to the Factory With A Future" (Figure 1).

Systematic planning is the key to staying alive in today's erratic environment. And it works best when it deals with the "now" and the foreseeable future, not 2001. For this reason, the first step is to develop a thorough master automation plan that reflects your business environment. Token robots and other isolated quick fixes can be a waste of time and money.

Before you can set down a realistic plan, however, there is a certain amount of self-analysis to be performed. You should examine your resources, your performance, your position against worldwide competitors and the business environment. Once you

understand how all the equipment and processes in the office and plant can interact, you can pinpoint areas that can benefit the most from automation. Your goal is not to automate as much as you can, but as much as you should.

Once you have a road map and timetable for automation, then you can begin to search out the best automation technology for your business.

Remember, automation in your plant won't happen overnight. It is a long-range project. But the course can be run successfully and predictably if the time and talent are applied to develop a plan that "pays-for-itself-as-you-go-along."

Operations Management

After the planning is completed, you must concentrate on developing an Operations Management System. Operations management is the "up front" part of any manufacturing business. It includes automated order entry, purchasing, cost accounting, production planning and control, and shop floor control. Any factory, no matter how automated or efficient it may be downstream, is built on sand if this operation is neglected.

GE has used its own factories

as test sites to refine this area of automation. One result is MIMS (Manufacturing Information Management System), a software package which is designed to eliminate waste materials, inefficient inventory control, production bottlenecks and machine slowdowns.

MIMS provides tight control over the entire manufacturing process from purchasing to shipping, and integrates the key aspects of operations into one central data base. Other software programs are also available which can help tie together order entry, order release, accounts receivable, shipping/billing and inventory management.

Computer-Aided Engineering

Computer-aided engineering is an area that reduces the design cycle, lowers the product cost and enhances product features and quality dramatically. It includes the design and analysis of the product itself, NC machine tool and robot work programming, design of the molds and tools, quality control and process planning.

The weakness in most factories today exists because the link between design and production is made of paper: blueprints, drawings, paper tape, etc. Paper-generated errors and inefficiency show up in engineering or accounting. They surface as chaos in manufacturing, causing skilled craftsmen to waste time fitting square pegs in round holes.

You can now computerize the entire product development process from the conceptual state in the engineer's brain all the way through to production without paper.

CAD/CAM

CAD is more important in improving product quality and overall productivity than robots, computers or virtually any other piece of equipment you could add to your business. The reason: it will enable you to create higher quality products and get them to market faster, with higher profit margins.



Figure 3: GE IPARS Vision system reads characters on various surfaces.

CAD can give your plant sophisticated design capability—and it can be on-line in a matter of months. The versatility of CAD technology is limited only by your engineers' imagination. They can perform mechanical design, architectural work, integrated circuit designs, and produce complex piping layouts for chemical plants—virtually anything done today in blueprints.

CAD enables engineers to create designs with far greater accuracy than ever before and to explore alternative designs whenever they want simply by calling up production designs from computer memory. Since CAD creates a common data base, design information can be shared via a paperless link with manufacturing and engineering, or even a supplier. Data for computer-aided manufacturing can be downloaded directly to the shop floor to operate numerically controlled machine tools and robots.

With properly applied CAD/CAM, design cycle time can be reduced by over 30%, and manufacturing productivity increased by 20–30%.

Even some makers of disposable diapers have discovered CAD. Formerly, when they wished to change their designs, they brought in scores of howling infants to model for mannequins and then—by trial and error—fitted the new diapers to the mannequins. Now they have every possible baby-bottom size and shape in the computer and can fit, stretch

and determine load-bearing characteristics under a variety of environmental conditions in the CAD system.

Product Analysis

Special software developed by General Electric CAE-International, Inc. can enable designers to see the effects of stress, vibration, shock, heat and other outside forces on designs, allowing them to make structural changes and select different materials to obtain an optimum design even before the prototype is built.

Instead of following the old process of bouncing a prototype around from model shop to testing area and back to design, engineers can now create these mathematical models and test these in the computer. They can move it, shake it, pull it apart and abuse it until it breaks. By the elimination of one or more conventional prototypes, CAE software can reduce development costs by hundreds of thousands of dollars, and allow you to get your product to the marketplace significantly ahead of schedule.

The obvious benefits of CAE software as a design tool are magnified when you consider productivity. By the time a computer-generated design hits the factory floor, you know it can be produced and that most, if not all, of the "kinks" have been worked out of it.

Another important adjunct to automated engineering is that now the technology is making it

possible to produce the NC tool path and program as a by-product of the design process. So, while designing and testing the product, you can access the same data bank in the computer to prepare tools and molds to be used in manufacturing the parts. And you can also use the electronic design data for quality assurance planning and to program automated test equipment downstream.

A key point to remember about CAE software is that whether 10 engineers or 100 are on the project, they are all looking at the same data base and product at the same time and can relate to its evolution through the design stages—a luxury not possible with blueprints.

CNC Advantages

One of the keys to increasing output and quality on the factory floor is the use of machine tools with computerized numerical controls (CNC).

If you cannot afford new machine tools, consider retrofitting older ones with the latest in CNC.

Equally flexible are programmable controllers, which can increase machine productivity up to 40%. Designed for the factory environment, they perform sequential functions, store large amounts of data and are quickly reprogrammed as you change the product or model mix.

Robots

Robots can give speed, precision and repeatability—which leads to better quality and lower cost products, and reduced rework, scrap and warranty costs.

In Japan, robots have not been a major issue among the workforce. The workers give their robots pet names and take pride in supervising them. Why? Because robots are not considered a threat in their fast growing industries.

General Electric will have approximately 400 robots operating in its plants this year and is one of the major users of robots in the U.S. And we are expanding. In 1983 & 1984 we'll be installing 50 new robots to help produce high-

Competing In The Computer Integrated Manufacturing Marketplace

World business competition is becoming more and more intense. As a result, US manufacturing capability is being challenged as never before. Companies that offer the highest-quality, lowest-cost product at the best level of customer service are winning in the race to capture world markets. Computer Integrated Manufacturing (CIM) is the key strategic tool that will determine who the winners are in the race to capture the dominant competitive edge in world manufacturing—those who are first in their respective industries to have their own "Factory of the Future."

The race by companies to implement CIM technology and integrate their design and manufacturing functions is creating a tremendous worldwide market for CIM technology and systems. In the US alone we estimate this CIM marketplace to be worth some \$28 billion (1982 dollars). This market will grow by about 14% per year to approximately \$104 billion by 1992. These figures can be multiplied by 2 1/2 to 3 times for the world's total CIM marketplace.

Such figures are meaningless, however, until tied to a definition of CIM. We define CIM to be the functional areas of Computer Aided Design (CAD), Group Technology (GT), Manufacturing Planning and Control Systems (MP&CS), Automated Material Handling (AMH), Computer Aided Manufacturing (CAM), and Robotics—all integrated by Computing Technology (C.T.), i.e., hardware, software, database, and telecommunications (**Figure 1**).

It is the latter area—Computing Technology—which dominates the CIM market as computers continue to permeate the entire manufacturing environment. We estimate that over the next decade, the computerization of engineering and manufacturing operations will mean that these functions account for some 50% of a corporation's total computer usage—up from the 30% we judge to be common today.

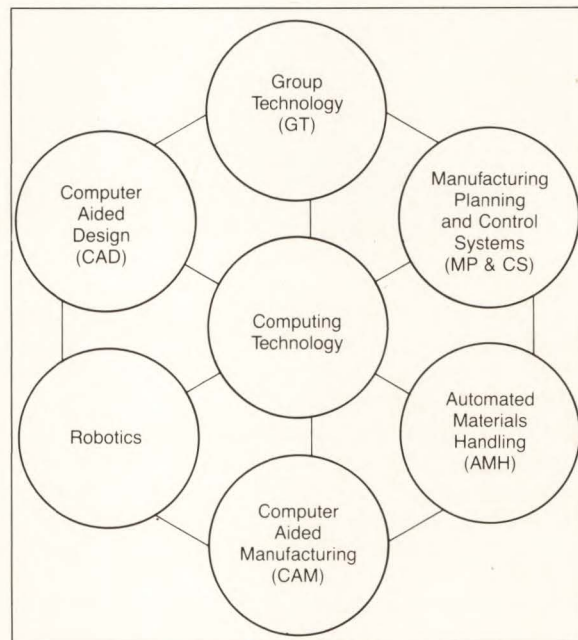


Figure 1: Definition of Computer Integrated Manufacturing by functional areas.

The tremendous CIM market size and the growth rate of some of its "hotter" segments such as CAD and Robotics, offer a golden opportunity for companies that compete in this arena, or even new entrants looking for new product/market opportunities. However, the rapid pace of technological change in this functionally broad and high growth market makes it essential for CIM market competitors to understand the

quality jet engine parts. Our experience has shown that robots can provide a quick payback.

A dull, repetitive job where robots pay off fast is welding, which once was regarded as a specialized, high-paying job. Now it is considered no more than a tedious and uncomfortable eight-hour ordeal. Robots make better welds—consistently.

Robots also have a place in routine assembly. The reason is that, unlike humans, they are maddeningly demanding. If materials provided to the robot aren't complete, uniform and reasonably flawless, it will either correct the

problem itself, call a human supervisor, or refuse to create what is certain to be a future rework problem at best, or more likely just scrap.

Strategically placed, robots can be a tremendous help in cutting costs and increasing productivity—but placing a sophisticated robot in the middle of an antiquated manufacturing operation is a waste of the robot's time and the user's money, and can wind up prejudicing everyone against using them in the future.

Automatic Inspection

Intelligent vision systems can

work with robots or independently to achieve dramatic improvements in quality control which will greatly reduce the chance of a defective product getting to the customer.

Non-contacting visual inspection systems can help determine that products meet specifications every step of the way. They have the capability to inspect parts for features and dimensions at speeds up to 900 per minute.

One intelligent vision system developed by GE is IPARS (Imaging Processing and Recognition System, **Figure 3**). This system helps ensure proper product

overall CIM framework and the forces driving both user implementation and CIM application product development.

This is especially true in a marketplace where the user's ability to understand and implement CIM applications, more than the demand for CIM benefits, may be the limiting factor in the sale of such products. From the vendor's viewpoint, the sales of his products may also be limited by his inability to integrate his CIM application into the user's overall CIM system or the systems offered by those companies dominating the CIM marketplace.

While it is important to keep one eye on the overall CIM framework, the market position, competitive posture, and product development plans of CIM competitors in narrow CIM market segments will also be important to understand. Finally, this knowledge must be understood in a global context, for many foreign companies and countries are beginning to realize the size, growth rate, and attractiveness of the CIM marketplace.

A key success factor for companies competing in

the CIM marketplace will be an understanding of how the user's buying center is changing, and the new criteria that will be utilized by top management to make CIM product investment decisions. As the influence of CIM systems spreads horizontally through companies, the buying center moves up the corporate ladder. With this change, the selling process must change from an emphasis on product technical features to one that focuses on the strategic benefits that will accrue to the company buying a given vendor's CIM equipment. CEO's and company directors must focus on their company's strategic posture. In short, how can their investment in CIM technology and equipment make them a more effective (and profitable) competitor in the world markets they serve.

The CIM vendors who can answer this question will have a powerful entree into a market with a guaranteed future as the US and many other countries in the world rebuild their manufacturing capability over the next ten to twenty years.

Thomas G. Gunn, Manager CIM Group, Arthur D. Little, Inc., Cambridge, MA. (617) 864-5770.

identification by automatically recognizing product ID characters—stamped, engraved or chalked—on individual parts or finished products. With IPARS, you can record the ID number of every component going into a product, such as an air conditioner. Later, if a problem surfaces with a certain production run of one of the components, you have the capability of pinpointing the exact model numbers of affected products requiring recall—as opposed to recalling the entire run to correct a problem that may be affecting only 1 or 2% of total production. The savings potential of this one application alone is astronomic.

Automatic Testing

Automated inspection and testing can contribute to product quality and eliminate DOAs (Dead On Arrivals) and their subsequent warranty costs.

Systems can be purchased from suppliers, or developed in-house, using the sequential logic functions of programmable controls. For example, circuit breakers can be tested at rates of up to 5000 per 8-hour shift using a programmable controller to direct eight test stations. Circuit breakers are checked to determine that they

are operating within prescribed limits, and are recalibrated automatically if they are out of the prescribed range.

Intelligent Warehousing

The average plant uses 50% of its floor space for storage and handling, while the average cube space is also only half utilized. The opportunities for better space utilization should be obvious.

In discrete parts manufacturing, the percentage of time a part is actually in process is just 5%-10%—about two to four hours a week. The rest of the time, material is being handled, moved, stored, retrieved, etc.

A partial answer to this inefficient use of space and manpower is the automated warehouse. Here parts are entered into a sealed, computer-controlled high-rise storage module and are never touched by human hands again until they reach a workstation. The advantages of computer controlled storage and retrieval of parts are many: it can't lose parts because a warehouseman put them in the wrong spot; it can't misplace parts in the wrong bin; and it can't "pick" the wrong part and deliver it to the factory floor.

The intelligent warehouse, like the automated factory itself, isn't

something you can order off the shelf. Planning and programming takes time, and it is easy to spend a million dollars or two getting it on line. But in the process you are also going to pick up a lot of new manufacturing space at no cost, which could postpone indefinitely the need for a costly new addition to your plant.

Data Management

Data management and communications is the nervous system of the automated factory, linking information generating "islands" together. This is where people, machines and processes are activated.

While every situation is different, and special to the business using it, there are six characteristics that a data management and communications system must have if it is going to work right:

- A computer or computer service appropriate in capability and cost to the customer's goals and leading resources.
- A central storage library, or data base, with common access that can be tapped by every machine and human in the factory.
- Interfaces to common systems to move electronic data.
- Adaptive people interfaces to search out the right mix of proce-



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dures between people and automation systems.

- Data structure and data management tools to eliminate duplications and contradictory orders.

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Integration of these functions is the key to the ultimate success of factory automation, and a high-speed electronic data highway is a necessary condition for such integration. Local area networks can be used to link PCs, NCs, interactive graphics systems, and other intelligent products, as well as the various automation islands.

The local area network replaces "sneaker power"—the present method of delivering paper and magnetic tapes in too many factories—to make possible real-time decision making.

As factories become more automated, reactions to and contin-

gencies for unforeseen or random events must be anticipated and programmed into the system. This also implies that the status monitoring and control execution functions must be an integral part of the factory system.

Summary

Over the past few years there has been much hand-wringing, as well as gloom and doom rhetoric about America's inability to take on foreign competition in world markets, let alone our own.

Don't buy this defeatism. We've taken a couple of body blows from abroad and we'll take a few more. But we're not down for the count by any means.

Visitors at the International Machine Tool Show last fall, saw a quarter of a billion dollars worth of advanced μ P-based automated machinery, a large percentage of it American-made, performing *magic*. Nearly 100,000

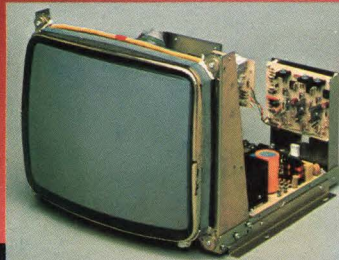
manufacturing people toured the exhibits, and the atmosphere was closer to D-Day than Dunkirk.

On some of the exhibits, the American flag was prominently displayed and "Made in the U.S." in oversized letters was clearly visible on many of the machines. That spirit is healthy, especially coming off a binge of national self-doubt. But waving the flag isn't what's going to keep us in business. GE has found in our international marketing skirmishes that "Made in America" doesn't cut it anymore unless the product is the most technically advanced or the least expensive, or both.

It's a world market with world class competition, and systematic planning, and implementation of electronics technology is the only way to play to win.

I'm often asked, how much automation is necessary. My reply has been standard: More than your competition. ☐

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Full Color From An Electrostatic Plotter

by Dr. Pat O'Connell

Almost five years ago, research conducted at the RD&E department of Versatec (a Xerox company) determined the feasibility of a color electrostatic plotter. It wasn't until November, 1980, however, that a task force was formed to develop a new color machine.

A survey of Versatec's customer base served as a catalyst to spur faster development. It indicated that more than 85% of all CAD

and geophysical plotter users wanted electrostatic color. Designers told us that color hard copy could improve design quality and turnaround. For example, a designer of printed circuit boards can use color to define circuit layers, intersections, and various device types. Yet while newer CAD systems offer color display, producing color hard copy has been impractical in most design applications.

Although pen plotters can draw in color, they are extremely slow, especially when attempting plots more complex than simple bar graphs. Drawing IC, PCB or complex mechanical drawings requires many hours, continuing operator intervention, and high maintenance

Precise dot registration proved the most difficult problem in designing a color electrostatic plotter.

Figure 1: An example of color output from Versatec's Electron electrostatic color plotter.

cost. Plotting a million or more vectors as needed for VLSI designs is simply impossible, as are plots with large solid or shaded areas. Even with simple plots, the user has a limited color palette that severely restricts color selection and utility.

Ink jet devices are somewhat faster, but output quality is inconsistent, format and plot size are limited, and maintenance is a continuing problem. Photoplotters provide excellent accuracy but are extremely expensive (typically over \$200,000) and very slow.

Because of the nature of electrostatic technology, producing complex plots in color is inherently easy—at least in concept. Programmed voltage is applied to an array of densely spaced (200 per linear inch) writing nibs embedded in a stationary writing head. Upon digital command, the nibs selectively create minute electrostatic dots on the paper passing over the head. The paper is then exposed to liquid toner, producing a permanent image.

This means that any image that can be digitized can be plotted. Speed is a function of paper movement, not mechanical arm movement. A raster line of data can be sent to the plotter and be reproduced on hard copy within msec's. This is why electrostatic monochrome plotters can produce draw-

Dr. Pat O'Connell is Manager, Electronics Research for Versatec (A Xerox Co.), 2710 Walsh Ave., Santa Clara, CA 95051.

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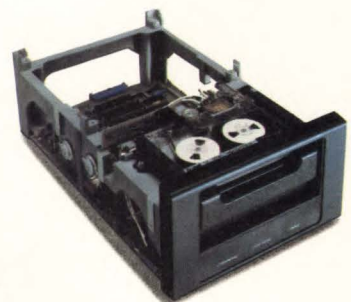
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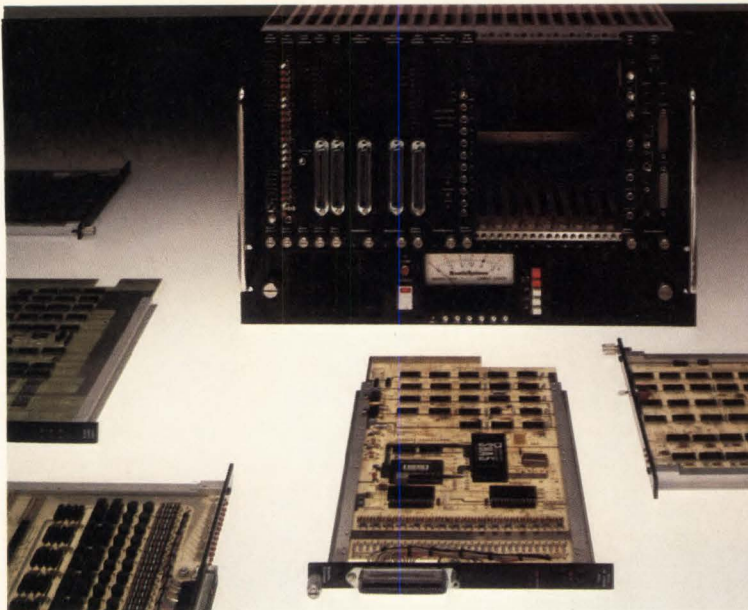
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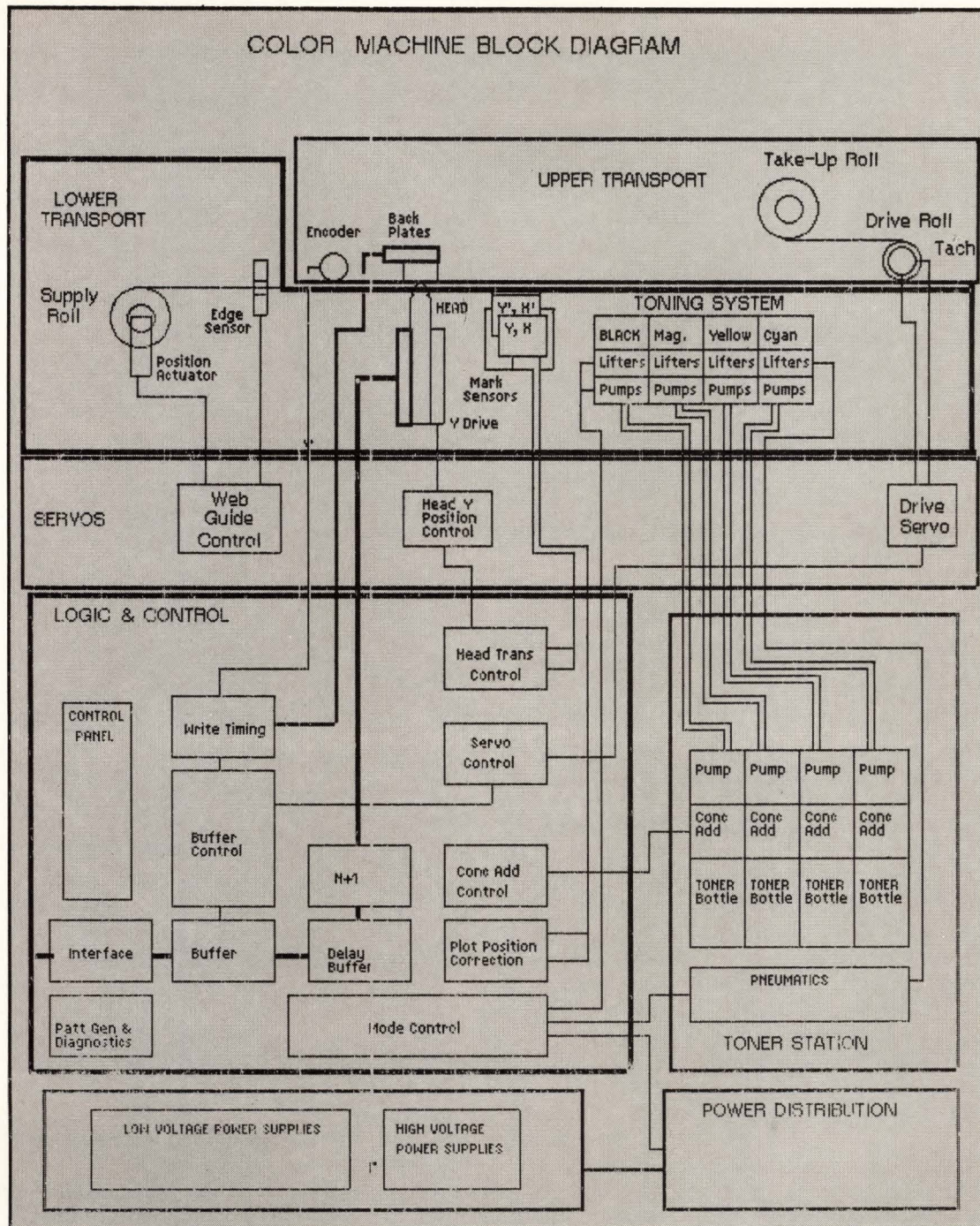


Figure 2: Electron plotter block diagram.

ings of several million vectors in a matter of minutes.

Based on this technology, producing color was relatively easy. We could simply run paper through four monochrome plotters, each using a different color fountain. This approach achieved a somewhat acceptable plot. It was pretty and colorful, but expensive, because multiple writing heads and

high voltage drivers increased cost to an unacceptable level. Moreover, maintaining registration among four writing heads, even with the most precisely manufactured heads, was difficult. The solution was to use a single writing head with associated drivers, as used in conventional monochrome electrostatic plotters. Use of four passes, each writing one color from one of

four toner fountains, allowed overlaying of color to produce a broad spectrum of colors. Further, formulation of improved toners allowed colors to become more additive and brilliant, and made possible a selection of over 400 colors.

A Consistent Image

Paper registration remained a problem. The first hurdle was the medi-

VERSATEC ELECTROSTATIC COLOR PLOTTER Specifications

Technology	Electrostatic
Resolution	Single stationary head and four toner fountains 40,000 points per square inch
Toner colors	Magenta, cyan, yellow and black
Writing speed	1 inch per second
Rewind speed	10 inches per second
Paper width	42 inches
Registration	Within 2 mils
Plotting width	
	In color mode 40.16 inches
	In monochrome mode 40.96 inches
Plotting length	
	In color mode 50 feet
	In monochrome mode 500 feet
Interface	Standard Versatec
Media	Standard Versatec

Table 1: Versatec's electrostatic color plotter features a resolution of 40,000 points per square inch and full four-color plotting.

um itself. Paper is an inconstant medium. Heat, humidity, and even the wrap on the supply roll can affect the dimensionality of paper. The relative changes in dimension may be quite different in the two axes. Without correcting for changes in the paper, the machine's ability to place a dot at a specified location (machine accuracy) or its resolution (points per square inch) may not improve registration. Yet few printers or plotters do more than correct for gross skew.

Since each paper sample may have slightly different characteristics and response to environmental conditions, it was necessary to use computer simulation techniques to measure variance from a known reference.

Part of the solution was to improve the consistency of the medium. This was accomplished by pulling the paper off the supply roll before writing an image. Pulling the paper out on the flat bed exposes the paper to ambient heat and humidity, reduces curl, and enables pre-plot registration of the paper. While conditioning improved consistency, continual sensing and correct positioning in both the X and Y axes was also necessary to assure point for point registration through multiple passes.

A paper edge detector controlled skew, but it did not provide sufficient registration accuracy. There-

fore, a multi-directional sensing and correction system is employed. As the paper is conditioned, the machine encodes a series of registration marks and lines outside the plotting area. These provide a positive reference for sensing and correcting plot start, registration during plotting, and end of plot.

This is analogous to the closed loop track-following technique used in high performance disk drives. With a known reference, both disk drive and color plotter can achieve great accuracy, even under changing environmental conditions.

As the web guide control sensor and position actuator play out paper from the supply roll, the "Coarse X" servo and edge detector control the paper at commanded speed, prevent skew and keep the plot in the working zone. Finer registration is provided by sensor readings of the registration lines that run on both sides of the paper. Paper and head are adjusted to provide centering and registration with control parameters of 1/10 of a mil. To appreciate the accuracy of this registration, consider that each dot—one of 40,000 in each square inch—uses a 5 mil center, 50 times larger than control parameters.

In the paper travel axis, the registration marks are used to sense plot start, registration to plot length, and end of plot. Servos for

supply roll, capstan, and take-up roll adjust speed and positioning to accommodate changes in data rate or to modify registration. Again, accuracy is measured in fractions of a mil. And while modifying registration in the direction of paper travel might not be necessary in a short plot, the difference in registration accuracy is quite apparent in plots from five to fifty feet in length.

Although a single registration mark would provide greater accuracy than the typical electrostatic plotter, the use of a mark series has potent advantages. First, the series of marks provides a fail-safe measuring and correction technique. Secondly, it enables subtle, gradual correction rather than large, jumping movements.

With this accuracy in registration, the plotter can produce "electronic overlays": rather than plotting several individual overlays and attempting to mechanically sandwich several plots, layers can be plotted simultaneously, each in its own distinctive color.

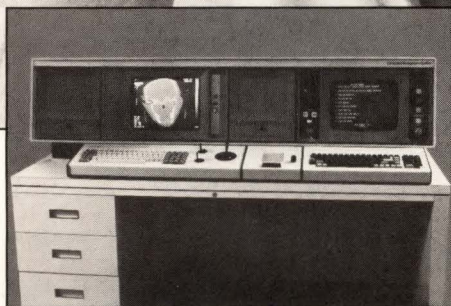
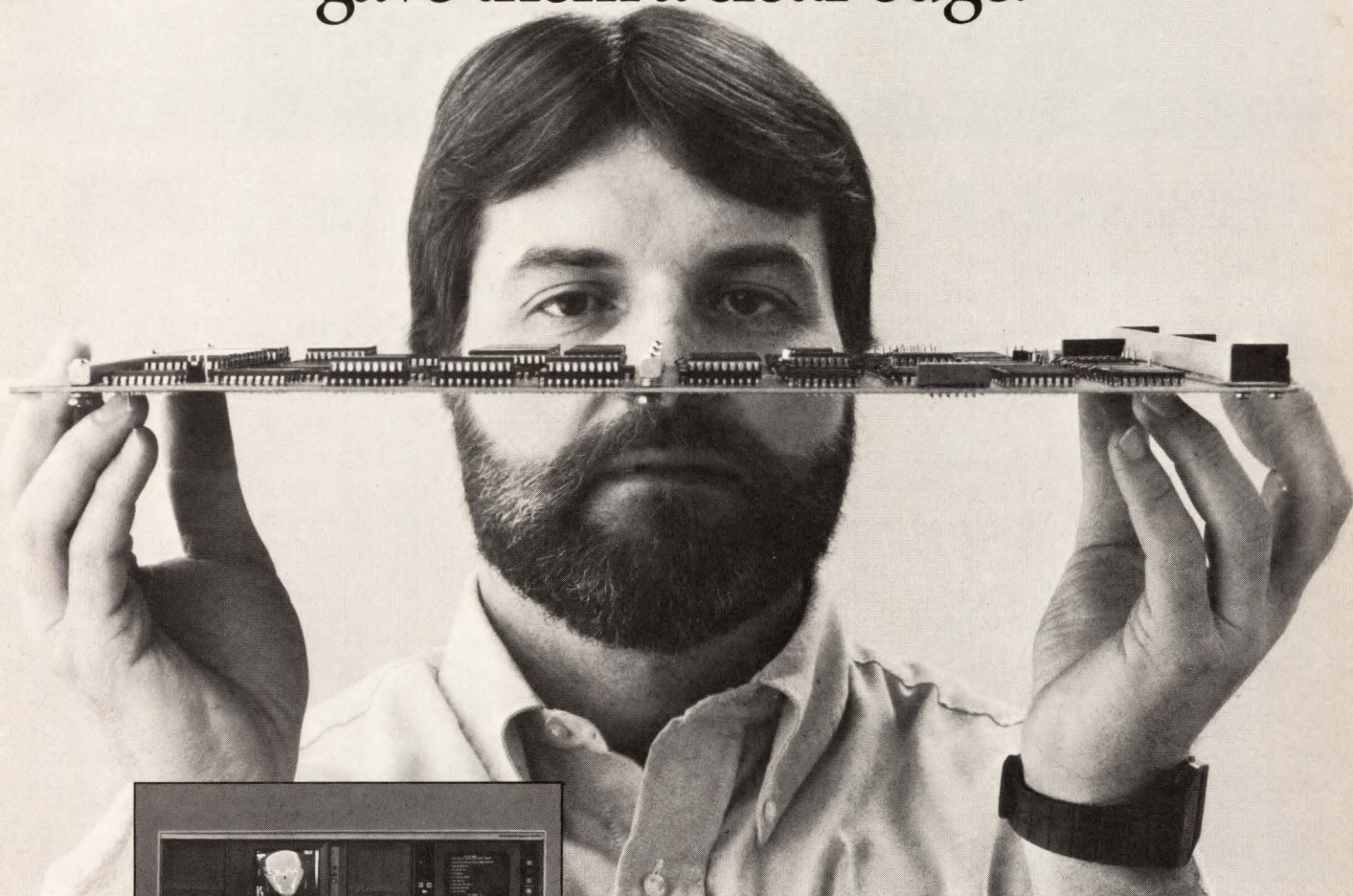
Electronic Improvements

On the electronics side, more efficient high voltage drivers require less power, reducing power consumption and heat. Improved switching power supplies designed to meet VDE specifications filter out line noise better than conventional power supplies. Although existing PCBs are used for interfacing and buffers, a higher degree of integration has reduced electronics part count.

The final machine produces the full color spectrum with translucent toners in magenta, yellow, cyan and black. Plotting on standard Versatec 42" wide roll paper, it draws color or monochrome plots. It can produce a full color E-size drawing (34" by 44") in eight minutes; a black and white drawing in less than 90 seconds. Resolution is 40,000 points per square inch; registration is within 2 mils.

The result is a new plotter that for the first time allows users of computer graphics to have access to fast, reliable, big format color plotting. □

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DEC Compatibility: The Changing Face Of Bus Structures

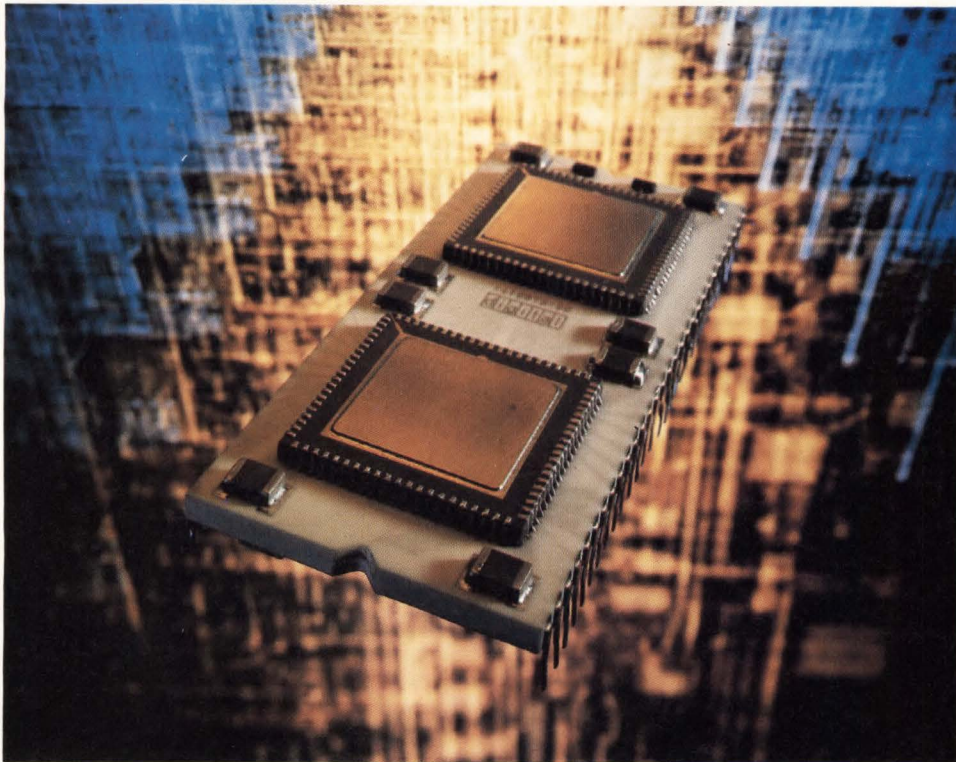


Photo courtesy Digital Equipment Corp.

by Dave Wilson, Senior Technical Editor

What will DEC do next? The position that most users and, perhaps more importantly, third party vendors must take, is just to sit and wait.

Most have their ears pointed toward the ether, hoping to piece together a trend from last year's DEC specifications, looking at ways to improve existing system performance. Or, they attend DEC symposiums, hoping to catch a glimpse of the giant computer company's future plans by a slipped remark here and there.

Many have made a profit by filling gaps in the market, since often DEC will introduce a computer line with some elements missing—if that need can be justified a third party will do it, often improving DEC sales with systems that become easier to integrate. When try-

ing to foresee new developments at DEC, it must be understood that one thing DEC tries, and succeeds upon capitalizing on, is continuity—it has a whole family of processors that are program compatible. It is easy for a user to migrate from one system to another. This, in itself, dictates that changes to bus structures will be more evolutionary than dramatic.

Changes in the Q-bus and Unibus structures of DEC's computer family appear to be imminent.

The Q-bus

The Q-bus has already gone through three evolutions. Starting out with 16-bit addressing and one level interrupt structure, it was a clear break from the PDP-11 that had 4 levels of interrupts and 18-bit addressing. The second step was to increase interrupt levels to 4 and to increase to 18-bits of addressing. Now, the user could choose an 11/23 instead of an 11/34, with the advantage that the micro-based product costs less and so do its peripherals. Then DEC moved to 22-bit addressing, gaining a capability greater than the 11/34, as far as memory addressing, since the user could access 4 Mbytes of memory. That made it very powerful, especially for those applications requiring large data bases. DEC has also recently announced a DMA enhancement that allows less overhead and faster throughput for

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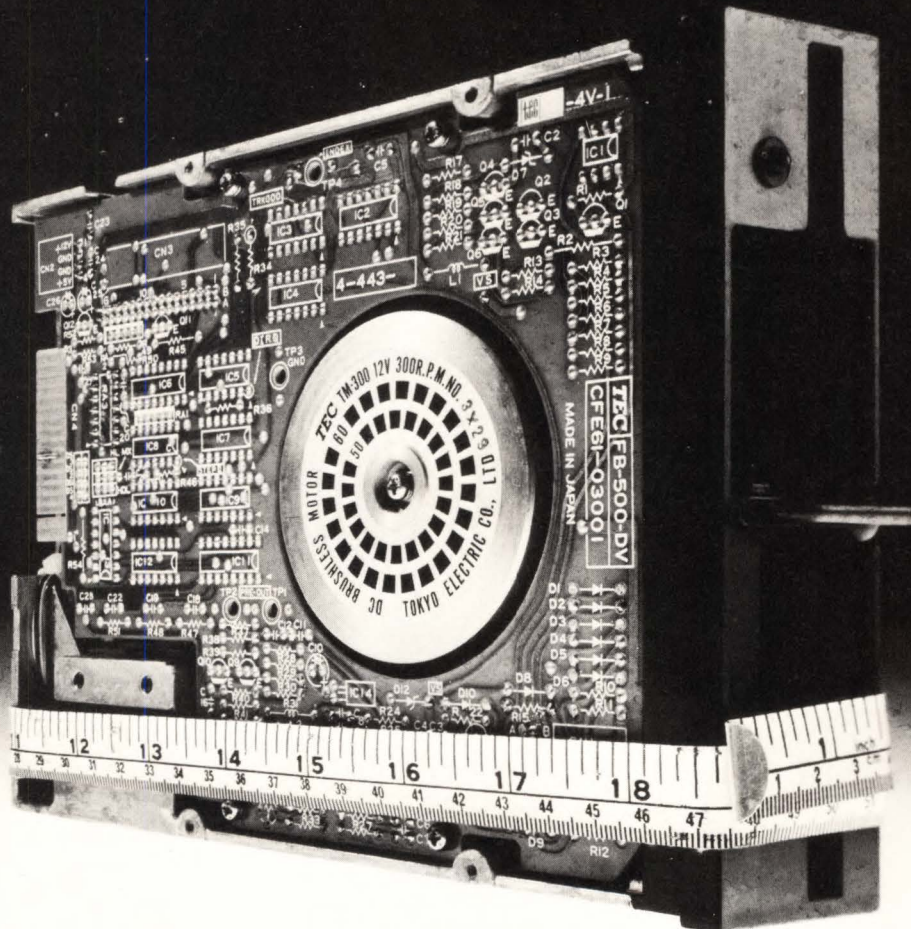
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DMA operations.

With 22-bit addressing, the user may need to put a larger number of memory boards onto the system. He then runs into the problem of how many boards he can put into a backplane before the power supply runs out. Although this problem has been overcome by larger backplane boxes with larger power supplies, it may be that the drivers and receivers may only be able to handle a certain number of bus loads. Third party vendors have solved this problem by introducing bus repeaters to extend the bus.

The Q-bus is defined at the moment as a single CPU bus. Although it can relinquish mastership to other devices, they are recognized as DMA devices. If the CPU's were front ended to appear to be DMA masters to each other, then they could gain mastership of the bus, leading to a multiple CPU configuration. However, as many third party vendors will agree, it's hard to second guess DEC.

Micro J-11

Many are looking to the micro J-11 as a possible answer to the question of the future of the Q-bus. The J-11 chip set (that implements a complete PDP 11/70 instruction set) would require a much faster bus than the current Q-bus and would be an inexpensive way to gain higher performance from existing systems. Another alternative may be found on the backplane of the system. DEC's CD interconnect, used to propagate TTL signals between an old two board disk controller set, has long since been disused. The new disk controllers fit into a single board that fits on the AB slots, but the backplanes still include those CD slots.

Will DEC come out with some backplanes that don't include the CD interconnect? There is no usefulness for it, and it could be used for more Q-bus modules. Or will it be used for another bus? It may well turn out to be a Q-bus look alike with a higher bandwidth.

Interest in DEC's bus structures is not limited to the Q-bus. There have been persistent rumors over the past six months about a high

speed Unibus that will run at least twice as fast as the present Unibus, together with discussions about the death of the Massbus. DEC does not intend to produce any new products that connect to the Massbus, but they do intend to sell and support current products. Apparently, the demise of the Massbus was caused in part by the difficulty in making it conform to FCC emission standards, and the fact that it was an expensive architecture to work with.

New drives produced by DEC are not compatible with the Massbus architecture and have significant price/performance advantages.

Many are looking to the micro J-11 as a possible answer to the future of the Q-bus.

Indeed, it would seem that DEC intends to take a tighter rein over its disk product range. Previously, they had always purchased disks, but now intend to manufacture. This may be a market reaction. DEC has been losing a portion of their marketplace and now intends to stop buying commercially available disks that third parties can also buy and add enhancements to at a later date.

With the introduction of their latest high-end disk and controller products, DEC has produced an intelligent subsystem concept that has moved most of the decision-making process away from the host.

The host is completely isolated from all details of device error, bad blocks and timing by the mass storage control protocol, that defines the nature and content of messages that are exchanged between a computer and an intelligent mass storage controller. The host can receive information that errors have occurred and have been dealt with,

but has little control over the way errors are processed.

The controller does not need to know what kind of error occurred or what retry strategy was attempted, but only whether or not the operation was successful. It would seem a natural progression for DEC to introduce a similar product line for the Q-bus that may be packaged with a 10 Mbyte Winchester and a floppy. But, will they manufacture or buy?

3rd Party Options

Many third party vendors are currently offering products to link the Unibus and Q-bus. The generation of a Q-bus on a Unibus machine has the distinct advantage that peripherals for the Q-bus are priced like the microcomputer itself, so much less expensive peripherals (and memory) can be placed on the PDP-11. The price of the Unibus/Q-bus link product is leveraged each time another Q-bus peripheral is placed on it.

When DEC first introduced the LSI-11, they did not introduce a whole range of cards that were program compatible with the Unibus; while they did have a processor card, they did not supply many peripheral products.

In these early stages, third party vendors may have even helped to sell the LSI-11 system by providing customers with peripherals that they could use immediately. Due to program compatibility, those vendors did not need to invent new software and diagnostics.

Conclusion

While the DEC compatible market currently offers a range of possibilities for third party vendors, the enormous amount of R&D effort DEC has placed on its new controllers will undoubtedly heighten the competition and the complexity of third party peripheral products. As yet, the undisclosed direction that DEC will take in implementing the Q-bus/Unibus changes do not help to keep those executive VP's feet on anything but shifting ground. For the DEC user, the benefits will include a wealth of new and innovative products. □

A CP/M Processor For LSI-11 And PDP-11 Computers

by Norman L. Rogers and Paul Mennen

The PDP-11 and LSI-11 are versatile, 16-bit minicomputers. A large amount of software which runs on these computers is available, but it is usually expensive. This may not be a problem for a large installation with many users and a budget to match, but smaller installations, whose entire computer system may have cost only \$10,000 cannot justify the purchase of software packages for thousands, or tens of thousands of dollars.

One alternative for the small user is to gain access to low-cost software by purchasing another computer such as the Osborne, Apple, or an IBM personal computer. The huge, installed base of these computers has turned the software they use into a high-volume business, thereby making it possible for the manufacturers to sell high quality products at quite low prices. Making this alternative quite attractive is that personal computers can be inexpensive—the Osborne, for example, sells for under \$2,000. But there's a catch: the performance of the lower-priced personal computers may be disappointing because they depend upon 5 1/4" diskettes for mass storage. If the personal computer is upgraded, with Winchester disks or other peripherals, its performance may be quite satisfactory, but its cost can then exceed \$10,000.

A solution to the software problem for PDP-11 and LSI-11 computers is to add a second processor capable of running low-cost, personal computer software. The idea

is not a new one. The IBM 1410 computers (1963), for example, could be made to execute the instructions set of the earlier 1401 computer by flipping a switch on the console; the Digital Equipment Corporation's VAX computer can execute the instruction set of the earlier PDP-11.

The declining cost of central pro-

PDP-11 and LSI-11 users can now gain access to the vast pool of CP/M software.

cessors and memories, which is not matched by any decline in the cost of software, makes the dual processor computer more and more attractive. Many of the newer personal and small business computers, which feature 16-bit μ Ps, such as the 8086 or 68000, also feature a Z80 processor which can run CP/M-80. A cynic might say that this gives the purchasers of these computers the distinct advantage of being able to run programs while they are waiting for the 16-bit software to be written.

CP/M-80, developed and sold by Digital Research, is an operating system for the 8080 and Z80 μ Ps and is used on 700 different microcomputers; it is estimated that 3000 different software packages are available which run under CP/M-80. It is so pervasive, in fact, that in computers that don't have the 8080 or the Z80 μ P, an auxiliary is added to allow CP/M to run.

Within the last year, a number of companies have introduced auxiliary Z80 processors for the PDP-11 and LSI-11 computers. In each case

these processors run CP/M-80 on a Z80 and are intended to give PDP-11 and LSI-11 users access to the vast pool of CP/M software. Alloy Electronics of Natick, MA has its CPM-11 card for the LSI-11; Virtual Microsystems of Berkeley, CA has its Z-board for the PDP-11 and the LSI-11; Decmation of San Jose, CA, has its D100U and D100Q cards for the PDP-11 and LSI-11.

In principle, the PDP-11 or LSI-11 memory could be used as the main memory for the auxiliary Z80 μ P, but all the manufacturers have elected to provide an independent 64 Kbyte memory for their Z80 μ Ps. The cost of memory is too low to justify the complication and performance sacrifice which would be required to use the 11 computer's memory on a DMA basis. The choice of the Z80, rather than the 8080, as the processor, is explained by the fact that the Z80 has a more general instruction set, yet will run 8080 programs without modification. Another factor is that the Z80 provides refresh and timing signals which make it easier to interface to 64K DRAMs.

The Z80 comes in 4-speed grades by maximum allowable clock frequency: the Z80 (2 MHz), the Z80A (4 MHz), the Z80B (6 MHz), and the Z80H (8 MHz). As it is a very recently announced product, the Z80H did not figure in the design of Decmation's Z80 processor card. Early in the design cycle it was decided that it was desirable, if at all possible, to run at the maximum possible clock rate of 6 MHz on the Z80B. It is very easy to interface dynamic RAMs to a Z80 up to a μ P clock rate of 4 or 5 MHz. At higher clock rates, the special timing signals generated by the μ P for dynamic RAMs no longer meet the specifications of 150 ns dynamic RAMs. This meant that additional timing circuitry had to

Norman L. Rogers and Paul Mennen are general partners with Decmation, 930 Tybalt Dr., San Jose, CA 95127.

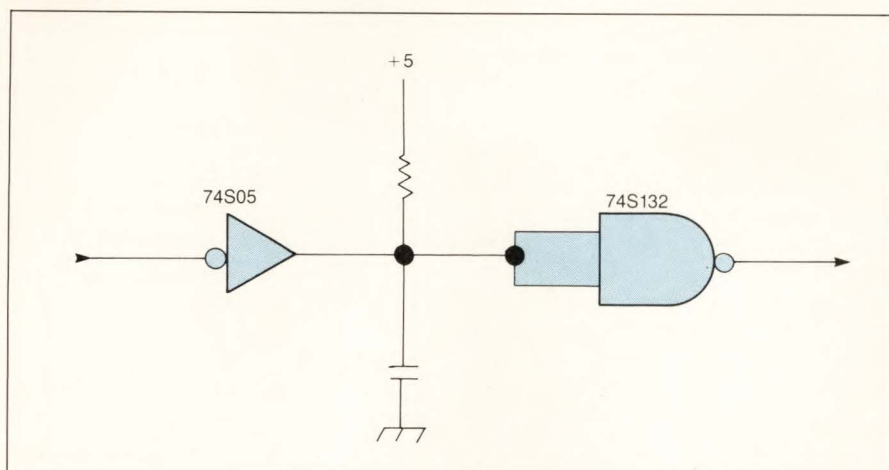


Figure 1: The S132 has a positive going threshold which is fast enough to minimize the uncertainty between minimum and maximum gate delays.

be added to modify the timing signals generated by the Z80 if the 6 MHz clock rate goal was to be achieved.

Several attempts were made to come up with a synchronous design for the dynamic RAM timing circuit. No satisfactory synchronous solution could be found which left, as the only solution, a chain of synchronous time delays. The timing precision required was not high, for example, $30 \text{ ns} \pm 10 \text{ ns}$. In one instance, the time delays required were typically too short for TTL time delay chips such as the LS122. Delay line modules were investigated as a possible solution, but they have the disadvantage of being expensive and generally single sourced. The solution finally settled upon was the simple circuit shown in **Figure 1**. The S132 has a positive going threshold which is stable over temperature, and the device is fast enough to minimize the uncertainty between minimum and maximum gate delays. The disadvantage is that the time delays have to be checked, and in a few instances the resistor values changed in production.

Another design objective was to use a simple 2-sided PC board. This proved to be difficult because the board was constrained by the requirement that it fit into an LSI-11 format which allowed only 40 in^2 of usable space for 54 ICs, including the 40-pin Z80 and a number of 20-pin packages. Dynamic RAMs

are extremely demanding upon the power distribution system because of the large, fast current surges during normal operation. The IC density did not permit space for extensive gridding of ground and power traces. In the interests of low-cost manufacture of the PC boards, the design rule of only one trace between the legs of ICs was followed. A prototype unit, built on a wire-wrap board with a complete ground and power plane and a decoupling capacitor for each IC, exhibited an unacceptable 0.5 Volts of noise on the ground plane, caused by the dynamic RAMs. Even placing a decoupling capacitor directly across the ground and power pins of the dynamic RAMs only reduced this

noise by about 30%. The inductance of the capacitor leads, amounting to only about 1 inch of wire, was great enough to negate much of the decoupling action. The solution to the problem was to use the flat decoupling capacitor, manufactured by the Rogers Corporation, which fit under the IC and solder into the board, sharing the same holes as the power and ground leads of the IC. These capacitors have $0.03 \mu\text{F}$ capacitance. An additional $0.1 \mu\text{F}$ capacitor was placed next to each dynamic RAM, connected by the shortest and broadest trace possible. This reduced the ground noise to a negligible 50 mV on the 2-sided PC board.

Another design goal was to use the same PC board and basic design for both the PDP-11 and the LSI-11 versions. Although the PDP-11 and LSI-11 have the same instruction set and run the same software, there is considerable difference in the computer buses. The PDP-11 uses a less complex bus, the Q-bus, on which the address and data buses are time multiplexed. In both computers the board geometry and power and ground assignments are the same. A common design was achieved which required a tolerable 24 jumpers. These jumpers are installed in production to determine if the board is destined to be a Q-bus or Unibus version. Since the two versions share the same drawings, nearly all the same parts, and

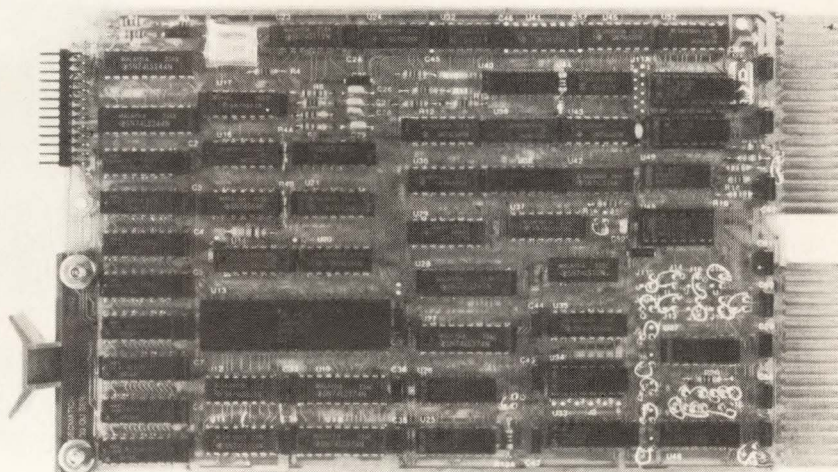


Figure 2: Within the last year, a number of companies have introduced auxiliary Z80 processors for the PDP-11 and LSI-11 computers.

the same software, the result was two products for nearly the development cost and overhead of one. If necessary, boards in inventory can be converted from one version to the other.

The interface to the PDP-11 or LSI-11 computer was accomplished by means of 4 memory mapped registers which allow the 11-computer to read and write directly in the Z80 memory. A control register allows the 11-computer to reset the Z80 processor to a wait state, and then to start a program executing by means of the Z80s nonmaskable interrupt. The 11-computer downloads the CP/M operating system and starts it. All I/O requests generated by CP/M are set up in tables within the Z80 memory which the 11-computer monitors. These are fixed locations within the "BIOS" or I/O section of the CP/M operating system. The BIOS is always at a fixed address in memory under CP/M. All I/O operations to the

various devices connected to the 11-computer are performed using the facilities provided by the 11 operating system.

CP/M uses disks, named A, B, C, etc., as its principal storage devices. Files, organized under the 11 operating system, serve as CP/M disks. Within the file, the organization of data follows that expected for a CP/M disk, with system tracks, a directory, and logical data blocks. Diskettes in CP/M format can also be used. This is a diskette format used to exchange data between CP/M systems and for the distribution of CP/M software.

A dual processor, PDP-11/Z80 computer running RT/11/CPM operating systems, provides a combination of two well-supported software systems. The CP/M system is good for word processing because there are numerous excellent packages available. Applications such as data base management can be accomplished very well on the Z80,

and at a much lower software cost compared to the 11. Because of the greater depth of software support available, the chance of finding specialized packages is greatest under CP/M. Examples of specialized packages include cross assemblers for other μ Ps, circuit and logic design programs, spelling checkers, scheduling programs, etc.

Since complete facilities for transferring data files back and forth between the CP/M formats and the 11 formats are provided, it becomes simpler to segment a job between the processors. For example, to perform editing of 11 source code under a word processor running under CP/M.

Another important advantage of CP/M is compatibility with most personal computers. A programmer can take work home, for example, prepare reports under *Wordstar* on a home computer, then continue the work on a dual, CP/M-PDP-11 computer at work. $\square$

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Optical Disks— New Media Promises High Bit Density

Existing storage media will come under heavy fire from new developments in optical technology over the next few years.

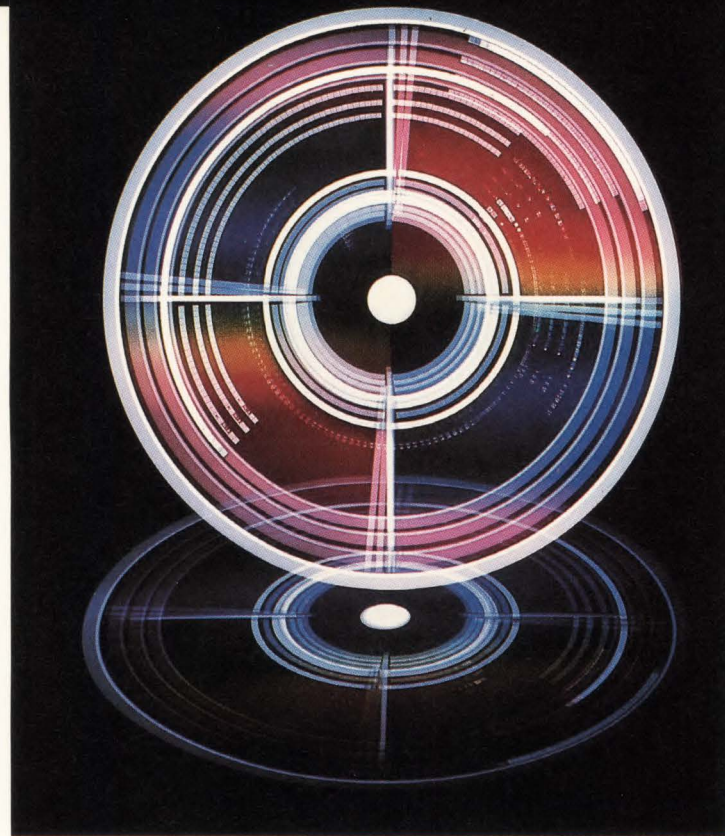


Figure 1: The Mnemos 12" plastic disk is produced by a process that employs electron beam and laser technologies to store over 6,000 pages of images.

by Dave Wilson

Following the wave of 30cm optical disk systems comes both compact optical memory, in the form of 12cm optical disks, and wallet-sized recordable cards. The storage capacity of these systems ranges from 1 million to 40 million bits for the card, and over 3.0 G-bits for a two-sided 12cm disk.

Old Versus New

Presently available data storage systems primarily use magnetic recording on tape and disks and photographic recording on microfiche. The cost of optical storage per Mbyte is considerably less than magnetic disk storage, based on the potential for storing substantially greater amounts of data on a single optical disk than on a magnetic disk of the same size.

Optical disk storage is also less expensive than magnetic tape storage on a media-cost-per-megabyte basis because of its greater potential for higher density. Moreover, unlike disks, magnetic tape in-

volves the time consuming process of rewinding the tape to find specific data.

Magnetic recording, however, does have advantages such as erasability of data and general commercial acceptance. While most presently known optical storage media cannot be erased, a similar effect may potentially be achievable through the use of coding and space reservation for additional data. Microfiche is an inexpensive method of storing data, but data recorded cannot be read immediately, as it can be using some optical storage media. In addition, access to data stored on microfiche takes from a few seconds to several minutes, depending on the sophistication of the retrieval equipment and the number of microfiche stored.

Optical Disk Technology

Advantages of optical data storage systems over available media include relatively fast access, long storage life, and low cost per Mbyte. Drexler Technology, Moun-

tain View, CA, has already announced a range of optical media product lines that include disk, memory cards and optical tape.

A single-sided 12" Drexon disk can store 1250 Mbytes of data that is recorded by a laser beam melting 0.5—1.0 micron holes in the reflective surface of the disk. Other disk products available include a 5" 200 Mbyte single sided disk, and one-sided 5" and 12" disks encapsulated for protection against scratches and dust.

In March 1982, Drexler announced a line of experimental optical disks, called Drexon II. Using the same photographic emulsion used in the manufacture of Drexon I, the new material is available in all of the company's disk product configurations.

Perhaps the product with the most obvious range of applications is the Drexon Laser memory card. Offered for sale in November 1981, it consists of a polyester-film based Drexon material encapsulated within a specially constructed card. Up to 5 million bits can be laser en-

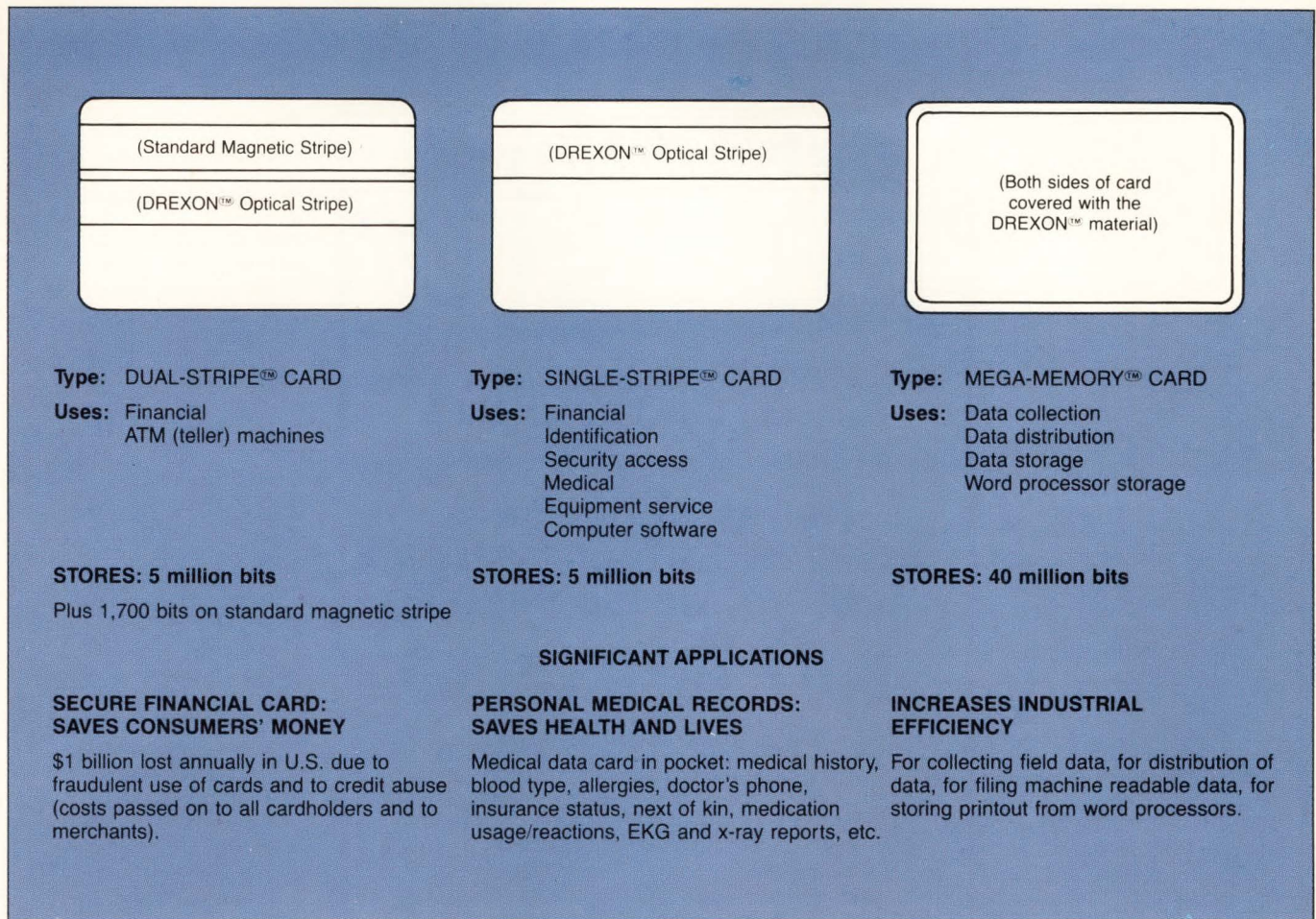


Figure 2: Drexon Laser Card configurations.

BUSINESS SYSTEMS PERIPHERALS

1987	1992
Floppy Disks - 60%	Floppy Disks - 48%
Hard Disks - 22%	Hard Disks - 12%
Optical Disks - 18%	Optical Disks - 40%

Table 1: A forecast of optical storage disks predicts it will be a \$9 billion industry by 1992 (source: International Resource Development).

coded onto a standard Drexon Laser Memory card, in comparison to the 1700 bits now used on credit cards. For even greater storage capacity, both sides of the Drexler card can be covered with Drexon, giving the card a capacity of 40 million bits. It can also contain a conventional magnetic stripe to allow for upward compatibility with existing magnetic systems, such as bank

ATMs. The major application areas seen by the company include software distribution for personal computers, μ Ps, word processors, etc, computer game software distribution and security.

Drexon optical tape is the latest laser recording product from Drexler. Announced in November 1981, the initial product was a 50' reel of 35 millimeter wide tape. When 5 micron size holes are recorded on an optical tape 2400' long and 70 millimeters wide, a single reel of tape can hold 50,000 Mbytes of data. Future use of 2.5 micron holes will allow 200,000 Mbytes to be stored on the same size tape.

The tape will be used for low-cost, off-line storage of sequential data that would otherwise be on magnetic tape. In these kinds of applications, the emphasis is on very

high storage capacity, permanence of storage and low cost per Mbyte of storage.

It is the firm intention of Drexler to keep both feet planted in the optical media field, and to allow other manufacturers to develop the necessary R/W equipment. Last October Drexler announced that Toshiba had become the first participant and licensee in Drexler Technologies Laser Memory Card Equipment Program, that will lead to prototype R/W equipment for the memory cards.

Accessing large volumes of information through the use of optical disk technology is also the philosophy behind the System 6000 from Mnemos, Lawrenceville, NJ. The system maintains records that have been electron-beam written onto a glass master and pressed out on a 12" disk. The disk is then inserted

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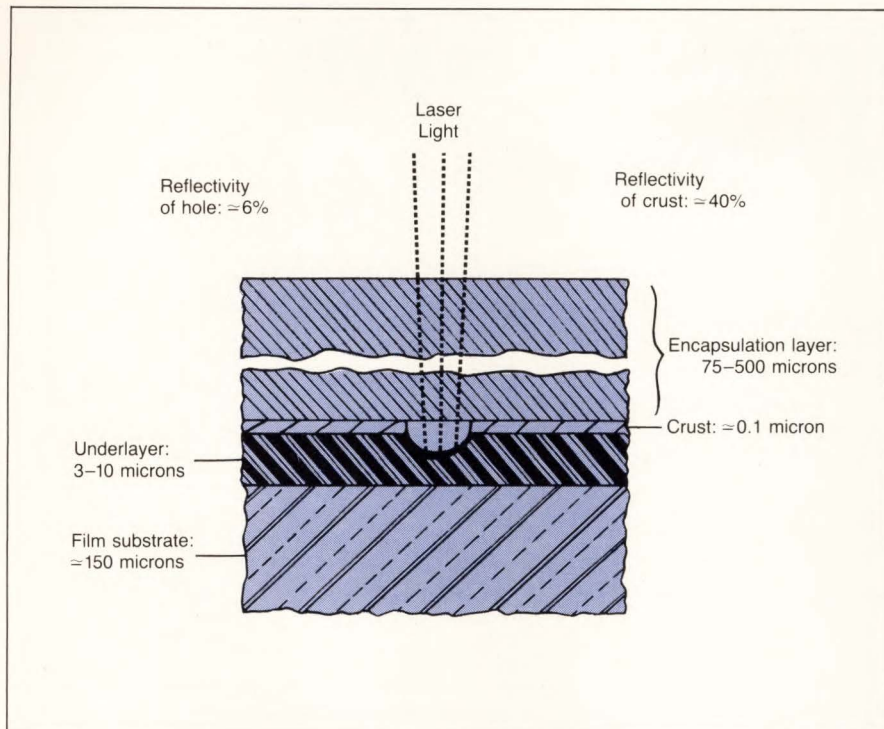


Figure 3: Structure of Drexon material for laser cards. On top of the polyester film substrate are three layers: an encapsulation layer, a crust, and an underlayer. The encapsulation layer is a thick, transparent, plastic coating. The crust consists of silver grains of filamentary and spherical shapes dispersed in an organic colloidal matrix. The underlayer consists of the same organic colloid but is essentially devoid of silver particles. The underlayer thermally insulates the reflective crust and increases the laser recording sensitivity. Digital data bits are recorded when a laser beam melts holes in the reflective surface of the material. The organic colloidal matrix melts at under 200°C, permitting the use of low power semiconductor-diode lasers. Data bits are decoded as the absence or presence of holes, as determined by the intensity of the reflected light.

into the System 6000 workstation, enabling the user to access a specific page or item on the disk. As well as storing digital data, laid out in bar codes in sectors along the annuli of the disk, the MnemoDisc holds page images reduced 88 times from the original.

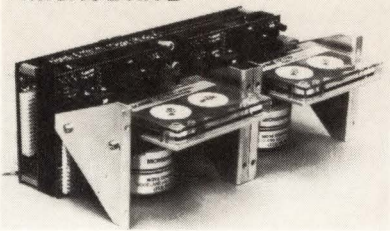
The digital information that is stored on the disks is read optically, and used to download search indexes, digital data or operational software from the disk to the μ P-based workstation. The user can then retrieve the actual image of an entire page or an individual item on a page by entering requests on the intelligent keyboard of the workstation.

The keyboard includes a standard typewriter layout and 12 dedi-

cated function keys to assist the operator in retrieving specific information through simple or complex "menu" driven indexing structures. In addition, the keyboard's 40-character digital display provides prompts, error messages, and "softkey" functions programmed to the user's specific application to further aid the information retrieval activity. Typical access times are on the order of one second, with the page images displayed on the workstation's rear projection screen.

The Mnemos workstation can be directly connected to a local computer system via an RS-232 communications interface or to remote computer systems via standard modems. □

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Advanced Streamers Solve Back-Up Problems

by Bob Hirshon

When streaming tape drives first came on the scene, their function was clear: to provide simple image back-up for small Winchester disks. In this application, the entire data file of a disk was transferred in its original form onto the tape, with no manipulation of individual data files. Streaming drives were ideal for this function, since they had a higher transfer rate than conventional start/stop drives; and, because they were relieved of the complex and expensive start/stop components, they were much cheaper. These two characteristics were crucial to the success of early streamers: they had to be fast enough to back up high capacity disks in a reasonable length of time, and they had to cost less than the drives they were backing up.

Advanced controllers, cache, and compatibility are keeping quarter-inch streaming cartridges the number one choice for Winchester back-up.

For a while, this was sufficient. But in the demanding small systems market which small Winchesters occupy, users wanted more. They wanted selective file retrieval, file manipulation, and interchangeabil-

ity of data files between different disks and even between drives of different manufacturers. The answer to these demands came not from advances in the tape drive itself, but from sophisticated controller technology, μ P-controlled cache memory, and intra-company cooperation.

Streamer Applications

The complex mechanics of start/stop drives allow them to stop precisely in inter-record gaps, and then rapidly accelerate to full speed to read or write data as it is transferred from the computer system. Streaming tape drives, lacking these mechanics, must slow to a stop, back up, and accelerate again to begin reading and writing data (**Figure 1**). Plainly, streaming drives were not designed for heavily interactive applications, and repositioning must be held to a minimum for a streaming drive to be efficient.

There are two basic types of Winchester disk back-up: *image back-up* and *selective file back-up*. With image back-up, the entire disk file is transferred intact onto the tape. Its purpose is to restore the entire file system after the data has been damaged or destroyed by an operator error, head crash, or other disaster. Image back-up serves purely as insurance; using it for anything else is difficult. For example, the only way to get back any specific file is to restore the entire disk image to a spare disk and then retrieve the specific file you want.

Interactive Back-Up

Selective file back-up sounds like exactly the sort of application one would want to avoid for streaming tape drives—interaction and reorganization of data throughout the back-up procedure. But advanced

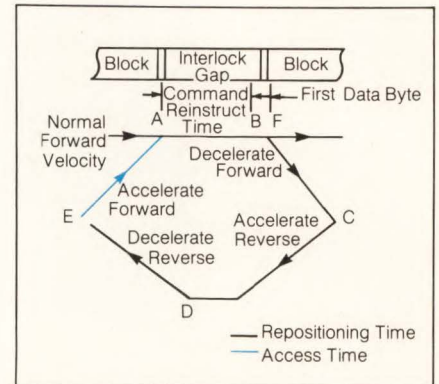


Figure 1: Streaming tape drives, lacking precise start/stop components, must slow to a stop, back up, and accelerate again to read and write data.

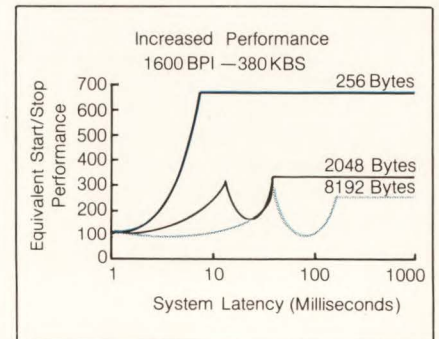


Figure 2: Cipher's μ P-controlled cache memory increases the performance of their $\frac{1}{2}$ " streaming drive, in some applications, over start/stop drives. As companies find less expensive ways to implement the technique, it will find its way into quarter-inch cartridge drives.

controllers allow streaming drives to perform some file restructuring with a minimum of time-consuming repositions.

Selective file back-up can be helpful in back-up applications. First of all, large portions of Winchester disks are often left unused, and a controller that allows these areas to be excluded from the back-up cycle saves both time and tape. New controllers allow specifi-

Current Cassette And Cartridge Tape Drive Model Offerings

US Manufacturers	Standard			Standard		
	Mini Cassette	3 KBS or Less	More Than 3 KBS	Mini Cartridge	1/4-Inch ST/Stop	1/4-Inch Stream Unique
Amilon Write 300		1			2	
Archive Write 301						9
Basic Four Write 302					1	
Braemar Write 303	4	5				
Cipher Write 304						8
Control Data Write 305						1
Datapoint Write 306						1
DEC Write 307				1		
DEI Write 308					1	10
Dicom Write 309		3				
Digi-Data Write 310					1	1
EPI Write 311				2	2	
Exatron Write 312						1
Facit Write 313		1				
Hewlett-Packard Write 314	1			1		
Interdyne Write 315		4				
Inwin/Olivetti Write 316				1		
Kennedy Write 317					2	
Memodyne Write 318		11	1			
Memorex Write 319				1		
MFE Write 320		3	10			
Mohawk Write 321					2	

US Manufacturers	Standard			Standard		
	Mini Cassette	3 KBS or Less	More Than 3 KBS	Mini Cartridge	1/4-Inch ST/Stop	1/4-Inch Stream Unique
Moya Write 322				3		
Northern Telecom Write 323		1			1	1
Qantex Write 324				2	6	1
Raymond Write 325	4	3	1		6	
Saylor Write 326			6			
Tektronix Write 327					2	
Techtran Write 328		3				
3M Write 329				2	1	2
Transaction Mgmt. Write 330				1		
Triple I Write 331		4				
Wangco Write 332						4
Japanese Mfrs.						
Sankyo Seiki Write 333				2		2
TEAC Write 334		6				1
European Mfrs.						
Feedback Data Write 335					4	
Penny & Giles Write 336					4	
Perex Write 337					2	
Philips Write 338	1	2				
Tandberg Write 339					1	4
Total Mfrs.	4	13	4	10	16	13
Total Models	10	47	18	16	38	45

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cation of the back-up starting address and the number of blocks to be transferred, and even record this file information onto the tape.

Often, disk drives have data partitioned into two or more "logical" disks on a single disk. Selective file back-up allows these "disks" to be backed up separately. Also, special data tracks can be kept separate, such as those containing bootstraps and operating system codes.

The latest controllers also allow reorganization of file data blocks; this means they can consolidate scattered data blocks into a contiguous section of the disk, without

going through host system memory. Then the organized data blocks can be transferred to the back-up tape. During back-up, the controller automatically records a user-assigned file ID, the total number of blocks in the file and the tape drive type. The user can then record further filing information, such as file name, file type, access protection bits, and then insert a "header" section for identification purposes at the beginning of the file.

New controllers can also correct for bad disk tracks. As disk capacity increases, so too does the number of defects on the disk surface.

With new controllers, the system software locates each bad track and replaces it with a good track somewhere else on the disk. Thereafter, whenever the software accesses blocks on the bad track, the controller automatically switches to the replacement track.

Not only does this work during Read/Write operations on the disk, but also for back-up and restore. During back-up, the bad track is bypassed and replaced by the good track. This effectively erases any trace of the original disk's defect; the tape has a perfect, defect-free image of the file. If this file is re-

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stored to another disk, the controller will automatically correct for any defects this new disk might have, replacing any bad track with a good one. This makes it easier to use the tape back-up cartridge as a medium for transporting programs and data between systems.

All of these functions have already been incorporated into single-board controllers, such as the Model 2000 from Sysgen Inc. (354 Reed St., Santa Clara, CA 95050), and are becoming increasingly available.

Cache Benefits

In addition to controller advances, sophisticated use of cache memory is also boosting the performance of streaming tape drives. Highly developed by Cipher Data Products (San Diego, CA) in a $\frac{1}{2}$ " format drive, the technology will ultimately find its way into $\frac{1}{4}$ " cartridge drives. The technique involves placing a μ P-controlled cache between the tape drives interface and its mechanics to act as a sort of "logical tape drive." Dubbed an "Electronic Capstan" by Cipher, the logical drive has a "head" that reads and writes onto electronic "tape" (the cache memory). All error correction and read-after-write checks are performed in the electronic tape drive.

The chief benefit of this approach is that it allows a mechanically simple, and therefore inexpensive, streaming tape drive to approximate the performance of a start/stop drive. The μ P, firmware and cache memory actually make the streaming tape drive appear to the computer system as if it were a start/stop drive, allowing it to read and write data in the streaming mode independently of the interface and without special software. According to Larry Hemmerich, VP and General Manager of Cipher's OEM Marketing Division, this technique "eliminates the problems created by having the interface slaved to the drive mechanics. Transfer rates are no longer limited to tape speed or data density and can be selectable by the user. Ramp delays are no longer the inverse of the tape speed. Where

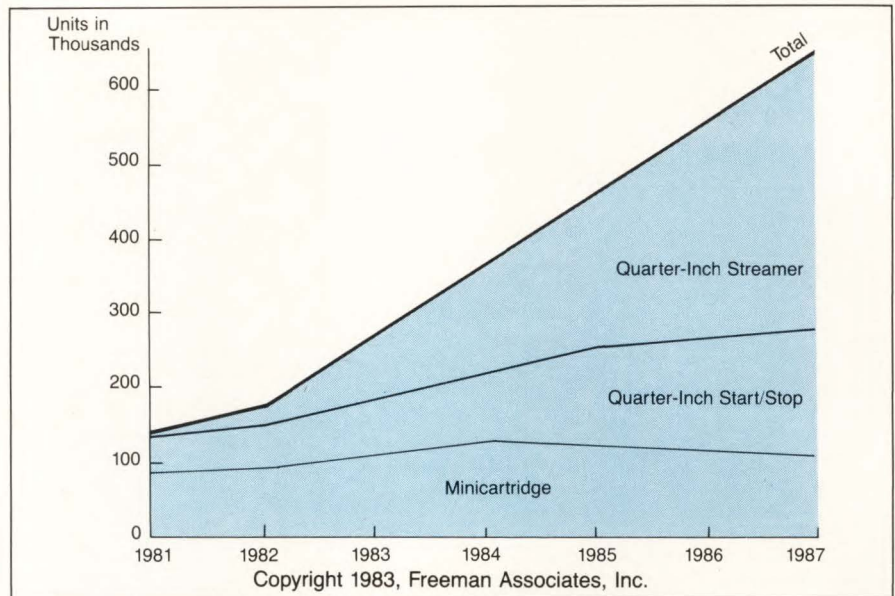


Figure 3: Projected worldwide shipments of cartridge tape drives.

(Units In Thousands)	1981	1982	1983	1984	1985	1986	1987
Minicartridge	88.1	96.7	113.9	127.0	125.0	120.0	110.0
Quarter-Inch Start/Stop	42.5	49.5	77.9	99.6	123.6	148.3	172.0
Quarter-Inch Streamer	9.5	28.8	80.0	145.0	217.0	295.0	375.0
Total	140.1	175.0	271.8	371.6	465.6	563.3	657.0
Growth From Previous Year	—	25%	55%	37%	25%	21%	17%

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Table 1: Total sales of cartridge and cassette tape drives will increase nearly four-fold in the next five years, according to Freeman Associates.

decreases in ramp delays or increases in transfer rates had reached the limitation of the ability to start and stop the tape in an economical manner, these are no longer valid. The tape drive itself is no longer the limiting factor in throughput."

With a transfer rate of 380 Kbytes/sec and a density of 1600 bpi, Hemmerich claims that a system writing a 256-character block every 10 msec would require a 650 ips start/stop drive (which doesn't exist) to give the same performance as drives employing the Electronic Capstan (Figure 2).

Cooperative Efforts

With increasing performance and decreasing prices, the only unresolved difficulty with quarter-inch streaming drives has been compati-

bility. To resolve that problem, the Working Group for Quarter-Inch Cartridge Drive Compatibility (QIC) was formed. Consisting of most of the leading industry manufacturers, the group indicates the recognition by tape drive companies that standardization, though often painful, is the only way to insure widespread acceptance of $\frac{1}{4}$ " tape cartridges.

Thus far, QIC has agreed upon a standard interface (QIC-II), and, more recently, a standard recording format. Called QIC-24, the format proposal specifies four- and nine-track formats, a unique address for each written block, and a track reference burst on track zero between beginning of tape (BOT) and load point (LP). QIC formally submitted the proposal to both the American National Standards Institute

(ANSI) and the European Computer Manufacturers Association (ECMA) for consideration as a worldwide standard.

Sixteen companies currently comprise QIC. Eight of them—Archive, Cipher, DEI, Irwin/Olivetti, Qantex, Sankyo Seiki, Tandberg, and Wangco—generated the QIC-24 proposal. The eight other companies, who acted as observer companies for this proposal, were ADES, Basic Four, BNR, Kennedy, Nortronics, Rosscomp, Sysgen, and TEAC. Ray Freeman, President of Freeman Associates, a Santa Barbara consulting firm, is spokesman and “facilitator” for QIC. The format agreement, he claims, “will permit interchangeability of recorded data cartridges across various manufacturers’ drives which comply with QIC-24.”

Back-Up Outlook

Floppy disk drives have a solid grip

on the low-capacity back-up market. Removable Winchester disks are becoming popular as fast, convenient integral back-up devices (see “Removable Winchesters Offer Simple Storage Solutions,” *Digital Design*, February, '83). But for most back-up applications in the medium- to high-capacity arena, especially where archival storage is needed, streaming tape is the number one choice, and is likely to remain so. And for small computer systems, which is where most of the smaller Winchesters are being incorporated, quarter-inch cartridges should remain the preferred format, especially with the success of current standardization efforts.

“Interchangeability of devices and recording media . . . were the two key factors which led to widespread acceptance of half-inch tape,” according to Freeman. He predicts the same will happen with quarter-inch cartridges. In fact, the

latest Freeman Associates report, entitled “Computer Tape Outlook—1982, Volume 1” (available from Freeman Associates, 311 E. Carrillo St., Santa Barbara, CA 93101. (805) 963-3853. \$1250.) predicts shipments of cartridge drives to grow at a 30% annual compounded rate. This represents a jump in unit sales from 175,000 units in 1982 to 650,000 units in 1987. In addition, by 1987 Freeman expects half the volume to be in the streaming category (**Figure 3**).

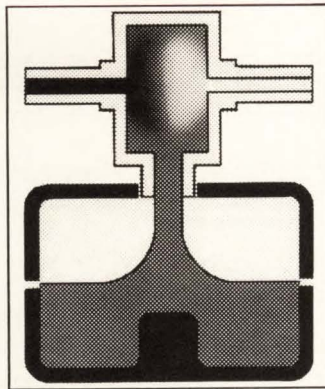
Less than a decade ago, many computer forecasters predicted quite a different future for tape drives as a storage medium. With the advent of fast, high capacity disks, tape drives were not expected to survive for long. Ironically, it has been disk drives, and their need for removable media back-up drives, that has made tape drives an integral part of today's small computer systems. □

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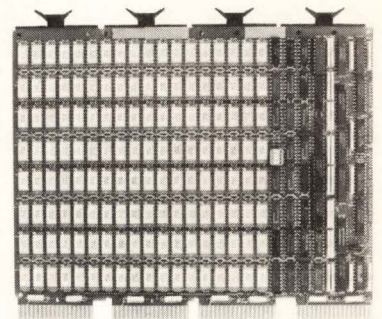
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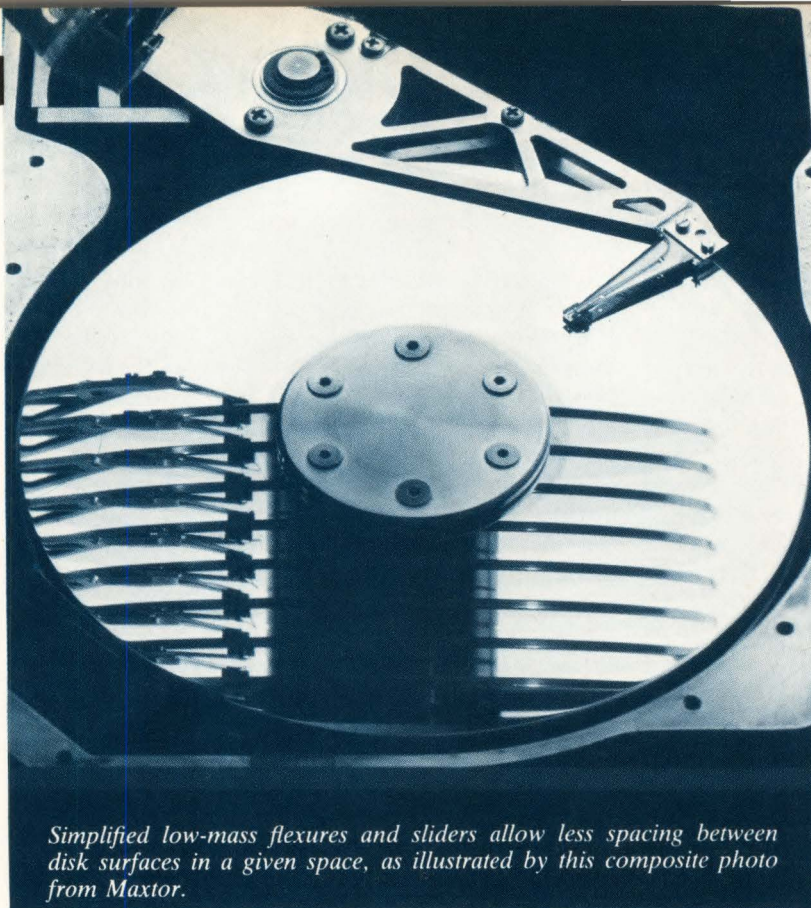
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Simplified low-mass flexures and sliders allow less spacing between disk surfaces in a given space, as illustrated by this composite photo from Maxtor.

Whitney Technology Moves Into Micro Winchester

by Jack Swartz and H.J. Kilsdonk

Traditionally, new technology is developed and proven by the giants of an industry, while new applications of proven technology are defined by smaller, more aggressive companies. Such is the case in the explosive, fast-moving magnetic recording disk drive market. While companies like IBM and Control Data have led to the development of new magnetic recording technology and disk drive design, smaller companies (among them Shugart, Tandon, Seagate, Quantum and Maxtor) have fueled market growth by incorporating those technologies into innovative, low-cost products. This is because the focus of the mainframe disk tech-

Jack Swartz is VP of Engineering and H.J. "Skip" Kilsdonk is Marketing Manager for Maxtor Corp., 5201 Lafayette St., Santa Clara, CA 95050.

Whitney technology, IBM's enhancement of their original Winchester design, is finding its way into micro Winchester drives.

nology has essentially been to increase gross storage capacity and data transfer rates to accommodate higher speed processors while the focus for the minicomputer and microcomputer suppliers has been more on low cost, small size, high reliability, and high manufacturability. High performance, too, is now becoming an additional major requirement for these suppliers. Whitney technology fulfills these

basic OEM requirements and, at the same time, provides substantial potential for future capacity and performance growth.

IBM's advanced Whitney 14" disk drive technology, for example, is being incorporated into smaller and smaller form factor disk drives in the same manner that its earlier Winchester technology was. Some of the same elements of Whitney technology incorporated last year by Amcodyne, Inc. in its 8" Model 7110 fixed/removable disk drive have now been introduced into 5¼" products with Maxtor Corp's recently announced XT-1000 disk drive family. Engineers at both companies chose to use Whitney technology head sliders and flexures instead of the more commonly used Winchester parts because the Whitney elements offered significant design advantages over their Winchester counterparts. Among the advantages: smaller size; lower mass; high load force; greater

structural stability; and improved electrical performance.

Whitney Advances

IBM introduced Winchester technology in 1973 on the IBM 3340; this was followed three years later by the 3350 which essentially enhanced the technology. Winchester technology was a dramatic change from the previously used 3330 technology; the Head/Disk Assembly (HDA) concept was introduced, head flying heights were reduced, and clean room production techniques were initiated.

IBM introduced Whitney technology in 1979 with the introduction of the 3370; this was followed shortly by the 3380. Whitney technology embodies a small-sized, low mass, ceramic slider with a deposited, thin film permalloy R/W element, an improved flexure design and Run-Length-Limited (RLL) encoding. The result was a significant maturing of Winchester performance (Figure 1).

Whitney Flexure. The Whitney flexure provides an extremely stable R/W platform. This is critically important since the head must be held rigidly in the plane of the disk, over the track, while at the same time following variations in the surface of the disk in order to maintain a consistent flying height.

The Whitney flexure is a small spring-steel suspension arm approximately 1" long; the head is attached to one end and the resultant head/flexure assembly is then attached to the head-arm. The Whitney flexure, when compared to the gimbal flexures of the older Winchester design (Figure 2), is inherently more stable. This increased stability means that there is less flutter during flying and hence

less chance of either a head crash or signal variations due to head flying instability.

Whitney Slider. Overall, the Whitney slider is much smaller and lower in mass than the Winchester slider. While the Winchester slider has a mass of over .10 gram, the Whitney slider has a 30% lower mass of less than .07 gram. This lower mass contributes greatly to the stability and compliance of the slider during flying.

Whitney Heads. The IBM Whitney thin-film head itself is deposited on the ceramic slider by manufacturing techniques similar to those used for manufacturing integrated circuits. The thin-film head allows a higher bit density and track density than obtainable with conventional ferrite heads because the gap dimensions can be made much smaller and more uniform than conventional machined gaps.

Whitney Encoding. The IBM Whitney encoding scheme (Figure 3) is a 2,7 Run-Length-Limited code that yields 50% more bits per inch than MFM encoded data. The 2,7 code specifies that there will never be fewer than two binary ZEROS between successive ONES, and never more than seven ZEROS (hence the run-length limitation).

Design Advantages

By using the Whitney head flexure and sliders, Maxtor engineers were able to design a 5¼" form factor product containing 8 disks and a recording density of over 10 Mbits/sq. in. The result is a 140 Mbyte, 5¼" disk drive that has higher capacity, higher performance, and greater margins than it would have had if it had been designed using standard Winchester technology.

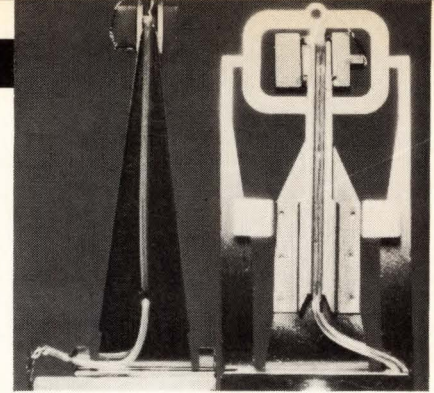


Figure 2: The Whitney flexure (left) is simpler and more stable than conventional gimbal Winchester flexures (right). Photo courtesy Amcodyne.

The XT-1000 family was designed to take advantage of all of the elements of Whitney technology; the initial product family, however, currently utilizes only the Whitney head flexure and slider technology. Thin film heads will be incorporated only when they are readily available in high volume quantities; RLL encoding will be used as soon as industry agreement is reached on a new standard interface to support the higher transfer rate.

Small Size

The smaller size of the Whitney head flexures and sliders allows disks to be spaced .100" closer together than when using Winchester heads. This closer spacing, coupled with the Maxtor's integrated motor/spindle combination, gains additional space inside the 5¼" package height to allow stacking eight disks, thus enabling Maxtor to achieve 140 Mbytes of unformatted storage in its drive (Figure 4). The smaller head is also less sensitive to cross-curvature of the disk, allowing the slider to fly closer to the disk surface. This allows higher achievable bit densities than attainable with Winchester technology.

The smaller size of the Whitney sliders, coupled with the elimination of the Winchester gimbal suspension, allows a higher utilization of the disk surface at the inner radius of the disk because the head can now move closer to the spindle. The two rail construction of the Whitney sliders, with the recording gap at the outermost edge, coupled with the smaller size of the sliders themselves, also allows a higher utilization of the disk surface at the outer radius since the recording gap is now at the outermost edge of the slider. This allows achieving the

	Whitney (3380)	Winchester (3350)
Bits/inch	15,000	6,425
Tracks/inch	800	480
Areal Density (Mbit/in ²)	12.0	3.08
Mbytes/spindle	1,260	317
Head flying height (μin.)	10	18
Avg. Access Time (msec)	16	25
Transfer rate (Mbyte/sec)	3.0	1.198

Figure 1: IBM's introduction of Whitney technology greatly improved disk drive performance.

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maximum amount of tracks (or cylinders) per surface regardless of the actual track density used.

Low Mass

The lower mass of the Whitney flexures and sliders, coupled with their higher load force when compared to the Winchester flexures and sliders, offers a number of other significant benefits to engineers.

The low mass slider (about 70% less than the Winchester) is better able to follow the minute irregularities of the disk surface. Because of this, the head can reliably fly closer to the surface of the disk, yielding higher achievable bit densities. The higher load force on the heads increases their flying stability and reduces the occurrence of "head slap" normally encountered during handling and shipping.

RLL Recording Codes

Run-length-limited recording codes are an element of Whitney technology that have not yet been widely adopted in smaller drives. Although the use of codes, like IBM's 2,7 RLL code, would allow manufacturers to increase drive capacity by adding more bits per inch, the current de facto 5¼" interface standard (Seagate's ST 506/412) does not support the higher transfer rate or non-MFM interface that the increased bit densities yield. Thus, any 5¼" disk drive utilizing RLL codes today would have a non-standard data rate and interface.

Manufacturers are currently discussing a modification of the standard ST 506/412 interface that would allow the use of RLL encoding and double the current ST506/412/5 MHz transfer rate. Market demand for such an interface is growing. This new standard, the Enhanced Small Disk Interface (ESDI) is expected to be adopted in the first half of 1983 by a majority of disk drive and controller manufacturers. This will result in a broader array of drive architectures with higher capacities, higher performance and lower cost per Mbyte for system designers. □

Figure 3: Two-of-seven run length limited (RLL) code is illustrated by the minimum and maximum number of non-transition locations (represented by 0) between transitions (represented by 1).

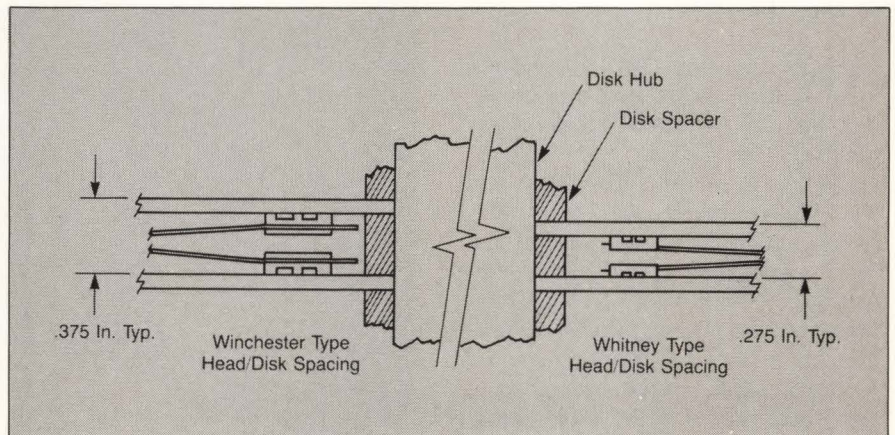
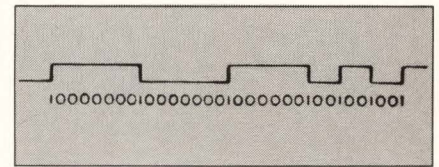


Figure 4: By using Whitney head flexures and sliders rather than conventional Winchester components, disks may be spaced .100" closer together.

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Portable Computers Find New Applications

by Jerry Borrell

When considering all of the trends in computing today, that of increasing capacity in smaller packages is perhaps the least remarkable. However, the rapid growth of the portable computer market is outpacing the predictions of even the most optimistic researchers. The numbers of units sold in the short time in which most portable systems have been on the market is an indicator that system developers are exploiting a sales niche unrivalled since the first computer kits were made available.

Portable computers have a potential for industrial applications, either as remote monitoring devices or intelligent terminals monitoring complex processes.

The wide range of applications for today's portable computers is a major reason for their success. No longer are they merely accessories for successful executives. In the area of process control or industrial engineering, portables have a potential for industry-wide applications—as remote monitoring devices or intelligent terminals monitoring complex processes. Engineers using computer systems find that the portable computers



Figure 1: Texas Instruments' Compact Computer 40 with printer/plotter, wafer tape and battery pack peripherals.

sold today provide viable alternatives to spending long hours in computer centers. The development of so many different types of portable computers reflects the nature of the computer industry today. Portables are often being designed by small firms in response to the need for low cost, high quality devices for the applications listed above. In turn, the computers provide professionals with new tools that allow small organizations to take on the work of larger companies.

Sudden Market Growth

There are several reasons for what appears to be a rapid growth in the sales and development of portable computer systems. The most obvious is the cost of the components necessary for the construction of such a system. The most popular processor, the Z80, for instance, is available at very low cost and has

the advantage of having accumulated a large body of applications software based around Digital Research's CP/M operating system. In terms of market, the demand for individual computers in professional and personal use is the largest market available to computer merchandisers. Since demand increases as cost is lowered, these factors have a cumulative affect upon general market demand.

Another important contribution of the new systems is their ease of use; not only is the applications software versatile, but the effort required to acquire and put one of the systems into running order is minimal.

Finally, the new systems are so powerful that a small business or an individual can safely purchase one of these less expensive computers and retain the functionality of much larger and more expensive systems. The fact that a system is

transportable seems to play a less important role than one might imagine—particularly in light of the marketing efforts by many of the companies. The real strengths seem to be in cost, size, capability, software, and in some cases portable features.

Manufacturer Sophistication

Despite the seeming newness of many of the manufacturers, the firms have developed marketing strategies that would be the envy of much older firms. For example, many of the advertisements for the portables are found in magazines such as *Business Week* or *Newsweek*, rather than in the trade press, for this is where they believe the majority of their customers are to be found. Nor have the new product announcements shown the lack of planning that often plagues new firms. At least six of the firms have designed their products to be compatible with the IBM PC; one firm (Kaypro) has announced an integrated hard disk, and several others will be providing an interface for external hard disks; several of the companies have devised systems with high quality graphics displays or have an interface to an external color monitor. All of these demonstrate that the design effort, while less complex than that needed

for much larger systems, has been given a great deal of examination.

Design Considerations

Perhaps the single most important factor in the design of the portables has been the method for providing a display. The type of display chosen is, in fact, the primary determinant of the actual physical size of the device. Few of the firms chose to provide systems entirely without integrated displays (Universal Research and Pied Piper are two exceptions). The majority of system developers have followed the lead of Osborne and incorporated a CRT, although almost all allow for 24 (or 25) lines of display with 25 characters in doing so. Almost a third of the systems, however, have made use of one of the flat panel technologies: plasma, electroluminescent, or LCD (LEDs and others, such as vacuum fluorescent devices, have not yet proved suitable).

The display is important not only from the point of view of the user who must be able to use the display comfortably, but from a design aspect, for there is a tremendous difference between the two technologies in terms of size and power consumption. The flat panel displays are currently available in smaller, line-type displays that force users to readjust to another



Figure 3: Access portable computer with integrated printer, acoustic modem and a 9" CRT display.

constraint, and so have not been as popular as CRT-based systems. Only one of the systems available to date incorporates a color monitor.

Keyboard Design

Keyboard design is the next important design criterion. The major dichotomy of designs is found in the selection of either a standard office-size keyboard or a smaller, calculator-size keyboard. If a standard keyboard is chosen, the size of the entire system is going to be greater. However, of the nearly one dozen systems that might be loosely classified as "handheld" computers, few have full size keyboards—Epson is the notable exception to the rule.

The smaller keyboards not only prevent efficient operation of the systems by typists, but prove hard to use in all but the most stable environment. The use of a system while in flight on a plane might be a measure of the practicality of a keyboard.

Of the full sized keyboards, the majority are designed to double as the lid for the computer. Only a few are truly detachable, as recommended under new ergonomic considerations. Little effort was made in the majority of the systems to provide additional logic or buffer-



Figure 2: STM Electronics' Pied Piper I includes 64 Kbytes of RAM, full ASCII keyboard, high capacity minifloppy with 256 Kbytes of storage, and built-in printer interface for Centronics/Epson-type devices.

ing in the keyboard itself.

Mass memory is one of the key areas of technology driving the practical use of these new systems. Portable computer designers are among the first to make use of 3½" drives, bubble memory, and 64K RAMs. The diversity of technologies used here shows the dynamic nature of these new firms. In terms of mass storage, Computer Devices and Tekelec (the developer of a portable test system) have implemented the Sony 3½" drives. Others, such as Kaypro, have integrated a hard disk drive into the system, while several of the firms have installed half-height floppy disk drives.

Pluggable Software

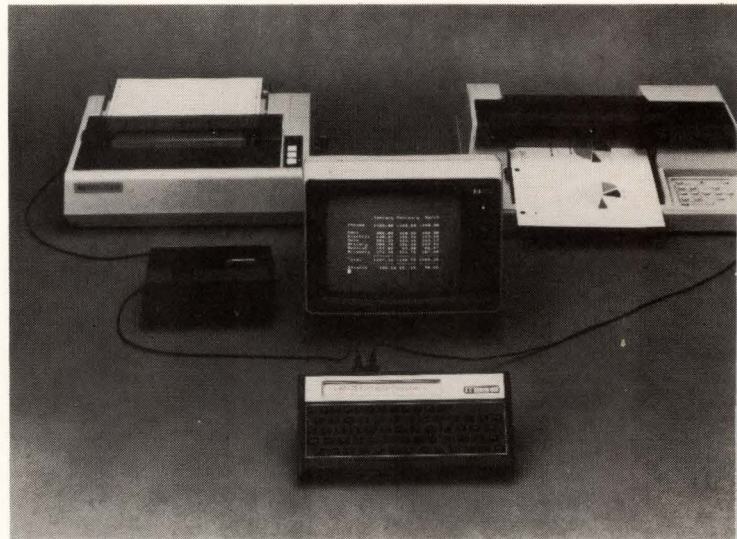
The most promising area of innovative design for these systems is found in those computers having modules for software which can be plugged in. These include Texas Instruments, Hewlett-Packard, Teleram, and Epson. The Teleram computer is the first of the portables to incorporate Intel's 128K bit bubble memory. The company may provide additional software on bubble cartridges.

Texas Instruments, the most advanced in terms of its offerings of pluggable software, has 8 programs prepared on their 128K ROM cartridge. Hewlett-Packard borrowed from its programmable calculator series to produce a system with chip-sized plug-in cartridges, but these are approximately 16K and so limited in terms of program housing.

TI and Epson offer accessory tape drives; Epson a tape cassette, and TI the newer wafer type drive system. The latter will allow up to 48K of storage. H-P's repertoire also includes some new technologies offering magnetic strips for storage of programs or data with each 8" strip containing 1300 bytes of data.

The diversity of new technologies being implemented on these systems shows that they represent more than just an important marketplace for small computers. Portables have, in fact, become a proving ground for new technology,

Figure 4: Hewlett-Packard's HP-75 portable computer with associated desktop peripherals.



possibly because of the relatively short time required to build new technology into a system. The advantages for semiconductor-based memory are obvious for systems that stress their portability; however, most office or professional software applications still push the limits of this type of storage. Therefore, most systems incorporate AC operated disk drives. There has been difficulty with the introduction of hard disk subsystems into portables. Kaypro, for instance, registered early problems with 5 Mbyte drives, but this is said to have been resolved.

System Compatibility

Six of the systems are compatible with the IBM-PC and a few even have expansion slots capable of accepting PC cards intended for the IBM product. The intent is two-fold: to benefit from the rapidly growing library of IBM software available for 16-bit microcomputers and to provide a transportable terminal that is capable of communicating with the host PC. The cottage industry rapidly growing up to supply additional PC boards for the IBM system may provide additional impetus for the PC compatible products because they are, in some cases, more powerful than the original IBM products.

Several of the computers have built-in printers, including Epson, Computer Devices and Applied Technology. Some, such as the Epson system and the Texas Instru-

ments system, are even able to print under their own battery power. These small printers are dot matrix, and can make a genuine claim to being printer/plotters because they can print graphics. Others, such as the H-P, have a micro-cable interface to true plotters so that they can produce charts and transparencies, making them more useful in business and office environments. The majority of the systems have RS-232 ports for printers, parallel ports, and some have IEEE 488 ports, which means they can be interfaced with letter quality printers.

Communications Features

A more telling capability needed for a truly portable system is found in its telecommunications capabilities. While all have at least one RS-232 port, only a few offer features such as switchable baud rates, built-in modems, modular modems, auto dialer features, and, in the case of Epson, an automatic log-in feature. These are the features already found in the existing body of send and send/receive terminals produced by firms such as Computer Devices, and it seems inappropriate to have to accept less capability from more "intelligent" and more expensive devices.

Several of the systems promote their graphics, and three—DOT, Hyperion, and Corona—have quite good display quality (i.e., over 512×512 resolution). One of the systems, the Portable Color Graph-

ics Computer, was designed for graphics, and interfaces with an RGB monitor for high resolution color graphics. Two others interface with color monitors, but the remainder provide only monochrome displays. However, any of the systems can be interfaced with color hardcopy devices such as slide making systems or plotters, so that color graphics are available, if not displayable.

It is useful to have a graphics capability, particularly in light of the graphics displays produced with the newer software packages for spreadsheets, income taxes, and business graphics. Demanding much more from the Z-80 based systems, at least as they are configured, would not do the systems justice.

System Packaging

The packaging on the systems varies widely. In terms of physical size there are the hand-held computers (the oldest of which are not considered here), the notebook sized systems (Epson, H-P, and TI), and the desk-top sized systems. Ostensibly they will all "fit under the seat of a 747"; however, the weight of many will prove tiring for all but the most athletic user. The advantages of the smaller devices are offset by a lack of display, but if they can be interfaced with video devices in the office or home, that may prove to be a less-than-necessary feature. Some of the screens are painfully small, and if combined with the need to scroll text as it is entered, the user must be especially flexible. There are also some questions about the ability of the housing of many of the systems to provide adequate cushioning of the systems during transport. It may be germane to note that the systems may have been advertised for under the seat because they would never survive a check-in for luggage handling. If treated as stationary, desk-top systems, on the other hand, they seem less user-friendly than systems commercially available. The bottom line may be that their low cost is at least partially a result of their packaging. There are even more reservations about applying the systems

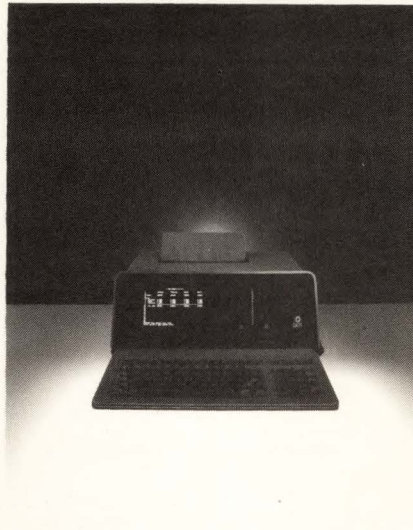


Figure 5: Computer Devices' 16 bit, IBM-PC compatible portable computer.

as industrial monitoring or remote devices in harsh environments.

Servicing and Maintenance

All of this relates to the question of services and maintenance. The caveats of home and hobby computers apply to many of these systems: announcements for the Nth quarter may or may not come true, new systems have new problems, and young companies cannot be expected to supply services on as national a basis as established concerns. The approach of a company like Kaypro, which has trained local dealers to service their computers, and which also allows the user to send the system back to the factory—is encouraging. There are also several questions about the approach of young companies to quality control—i.e., sufficient burn-in, test, and shipping—that will need to be resolved through painful experience. Most seem to recognize that their potential for a market share is based on the quality of the products they sell, and there have been no major mishaps with systems to date.

Market Developments

Evaluations of the size of the market vary wildly from one forecast to another. One source is quoted as predicting a unit market of 5.1 million systems by 1987, valued at \$3.1 billion. In terms of evaluating

the existing marketplace, the figures may be more vague—mainly because most of the companies are privately held. It is, however, generally agreed that Osborne is the early leader in the field, with approximately 50 percent of the market for 1982. The growth of revenues for companies involved is not always available, but if the figures for a company such as Kaypro (Non-Linear Systems) are an indicator, the market is booming. Sales in 1982 were over \$100 million, up from \$7 million in the previous year, and expected to rise to over \$150 million in 1983. With at least 30 firms in the marketplace, and many more on the way, competition will begin to dampen the growth at some point. This market segment, however, potentially the largest, may be able to absorb surprisingly high levels of new entries. Among the new systems will be Commodore and Apple.

One anomaly of the field is the ability of the new firms to grow with minimal financial support. Much like early Apple computers, many of the new companies sell their computers only on a "cash on receipt" basis. While this may limit the immediate growth to wider markets, it does provide the cash to fund plans and employee increases needed to meet demand. This may, in the near term, be more important for the young companies than holding paper investments from amortized equipment.

Summary

While the more general purpose systems are benefitting from this era of growth, other products, such as test equipment (Tekelec Chameleon) are beginning to enter the marketplace initiated by the computers found in this survey. The second generation of systems featuring greater portability, 16 and 32 bit μ Ps and features specific to applications will no doubt prove more useful in engineering and monitoring uses.

For the present, the systems offer the engineer more powerful desk-top tools, and at the same time provide office equipment for the smaller firm or entrepreneur.

Portable Computer Manufacturers

To obtain more information about the companies listed below, write in the appropriate
Write numbers on the *Digital Design* reader inquiry card.

Name/ Manufacturer	CPU	Data Storage	Operating System	Software Support	Power Supply	Price Range	Peripherals, Options	Ports	Size (inches) & Weight	Display
Fox/ Applied Technology Ventures Santa Ana, Ca Write 340	Z 80	64K RAM 8K ROM 400K disk drive	CP/M		AC		Built-in Printer S-100 adapter 300 to 19.6K baud switchable acoustic coupler	4 RS-232	16 × 21 × 7.5 31 lbs.	Plasma Display 6 lines 40 characters
Electric Briefcase/ Compal Los Angeles, Ca. Write 341	Z 80	64K RAM 2, 5/4 disk drives 400K or 1 drive & 1, 10 Megabyte hard disk	CP/M Basic OS	Compal Software	AC	\$1795 to \$4995	10 Megabyte hard disk 300 to 19K baud Data Comm. Link Printer (KAYPRO OEM)	RS-232	16 × 18 × 8½ 25 lbs.	9 inch CRT Monochrome
COMPAQ/ COMPAQ Computer Corp. Houston, Texas Write 342	8088 (16 bit) & 8087	124-256K RAM 320-640K disk drive	COMPAQ DOS CP/M86 USCD-P	IBM-PC Compatible	AC	\$3000 to \$4050	Cartridge tape Hard Disk Plotter Modem Printer expansion boards	RS-232 RS-170	20 × 8.5 × 16 28 lbs.	9" Monochrome 25 lines 80 characters
Dot/ Computer Devices Burlington, Mass Write 343	Z 80 (8 bit) & 8088 (16 bit) 8087 option	32-256K RAM 24K PROM 448K optional RAM 2, 3½ disks, 560K	CP/M 2.2 MS-DOS	IBM-PC Compatible Microsoft Datamension Timberline Relational Systems	AC	\$2995 to \$3995	Built-in Printer (132 Columns) 300, 300/1200 Bell 212A modems IBM-PC card slots available	RS-232 RS-170 RF Modulator	18 × 14.7 × 7.5 27 lbs.	9 inch CRT Monochrome 132, 80, or 40 characters in 25 or 16 lines
Corona PPC/ Corona Communications Westlake, Ca. Write 344	8088 (16 bit) 8087 optional	128K RAM 2, 5/4 disk drives 740K	MS-DOS CP/M 86	Microsoft Digital Engineering	AC	\$2395 to \$2995	10 Megabyte additional floppy drive	RS 232	18 × 8.5 × 10 28 lbs.	9 inch Mono- chrome CRT 80 × 24 640 × 250
DMS-31F Fox/ Digital Microsystems, Oakland, Ca. Write 345	2 Z 80A	64K RAM 2K ROM 2 disk drives 1.2 Megabytes	CP/M 2.2		AC	\$3995	Switchable Baud Rates	4 RS 232 parallel port RS 422	17.5 × 14.7 × 7.8 30 lbs.	9 inch CRT Monochrome 80 × 25
Hyperion/ Dynalogic Infotech Ottawa, Canada Write 346	8088 (16 bit) 8087 optional	256K RAM 2, 5/4 drives 640K	MS-DOS	Microsoft	AC	\$4995	IBM color graphics board 300 baud auto dialer switchable baud rates	RS 232 RS 423 RS 170 parallel port	18.3 × 11.3 × 8.8 21 lbs.	7 inch CRT, Monochrome 80 characters by 25 rows 640 × 325
Epson HX-20/ Epson, Los Angeles, Ca. Write 347	(2) Hitachi 6301 (8 bits)	16K RAM 32-64K ROM	BDOS	Epson Software	AC/DC	\$895	Modem RAM Expander Cassette Recorder Built-in printer 40 characters 110 to 4800 baud rates	RS 232	11.3 × 8.5 × 1.7 3lbs. & 13 ozs.	2 line- 40 character LCD
Thomas-2/ GRE RONG Electronics Taipei, Taiwan Write 348	Z 80A	64K RAM 4K ROM 2, 5/4 disk drives	CP/M	Osborne 1 & Apple II Compatible	AC/DC			RS 232 IEEE 488 RS 170	400mm × 360mm × 220mm 8.0 Kg.	7 inch CRT 80 × 24
HP 75C/ Hewlett Packard Palo Alto, Ca. Write 349	HP 8 bit Processor	16K RAM 3 expansion slots for 8&16K ROM	48K ROM OS	HP Software	AC/DC	\$995	Plotter 300 Baud Modem	RS 232 RS 170	10 × 5 × 1¼ 26 ounces	1 line 96 characters LCD
Access/ Matrix Corp. San Jose, Ca. Write 350	(5) Z 80A's	64K RAM 2.4K EPROMS 2, 5/4 disk drives 320K	CP/M2.2	Microsoft Digital Research Perfect Software	AC/DC	\$2495	Built-in Printer Acoustic Coupler Tractor Feed Battery Pack Double Density Disk	2 RS-232 parallel IEEE 488 RS 170	16 × 10 × 10 33 lbs.	7 inch CRT Monochrome 80 × 25

Name/ Manufacturer	CPU	Data Storage	Operating System	Software Support	Power Supply	Price Range	Peripherals, Options	Ports	Size (inches) & Weight	Display
M6000P/ Micro Source Inc., New Lebanon, Ohio Write 351	Z 80	64K RAM 2, 5¼ disk drives 772K	CP/M 2.2		AC/DC	\$3900 to \$7290	MC68000 upgrade direct connect modem, 0-1200 Baud acoustic modem, RS 232, parallel ports expansion card slots		17 × 20 × 17 35 lbs.	9 inch CRT 80 × 24
PC2000/ NEC Elk Grove, Illinois Write 352	78LC06 (8 bit)	8-16K RAM 20-36K ROM	N-Basic	PC 8000 & PC 8800 Compatible	AC/DC	Not Available		RS 232	225mm × 130mm × 32mm 600 grams	2 line 40 character LCD
Kaypro/ Nonlinear Systems Solana Beach, Ca. Write 353	Z-80 (8 bit)	64K RAM 2, 5¼ disk drives 400K or 1 drive & 1, 10 Megabyte hard disk	CP/M	Perfect Software	AC	\$1795	10 Megabyte hard disk 300 to 19K baud data comm. link printer	RS 232	16 × 18 × 8½ 25 lbs.	9 inch CRT Monochrome
Osborne Computer Corp. Hayworth, Ca. Write 354	Z 80	64K RAM 2, 5¼ disk drives 416K	CP/M	Digital Research	AC/DC	\$1795 to \$1995	50/80/100 character display upgrade	RS 232 IEEE 488	20 × 14 × 8 26 lbs.	5¼ inch CRT Monochrome 52 × 25
Otrona/ Otrona Corp. Boulder, CO Write 355	Z-80A 9517 processor	64K RAM 4K ROM 2, 5¼" disks 720K	CP/M	Microsoft Digital Research Micropro	AC	\$3995		RS-232 RS-422 RS-423 12 selectable baud rates	12 × 5.7 × 13.6 18 lbs.	5.5 inch CRT Monochrome
Portable Color Graphics Computer/ Computer System St. Claire Shores, MI Write 356	8088 (16 bit) Z 80 & 8087 optional	64 to 512K RAM 2, 5¼" disk drives, 1 Megabyte	MP/M 86 MS/DOS CP/M	Basic & DOS	AC/DC	\$3388 to \$3688	Plotters IBM card slots RGB CRT 1000 × 1000 Battery Pack Modem	RS 232 IEEE 488 RS 170	7.5 × 19 × 16 25 lbs.	7 inch CRT Monochrome or color monitor 80 × 40 character
Chameleon/ Seequa Computer, Annapolis, Md. Write 357	Z-80-A (8 bit) 8088 (16 bit)	8K ROM 128-256K RAM 640K disk	MS DOS	IBM-PC Compatible	AC	\$1900	Printer Hard Disk Expansion Box IEEE-488 8087-coprocessor	RS 232 RS 170	8 × 18 × 15.5 28 lbs.	9" Monochrome 25 lines 80 characters 320 × 200 or 640 × 200
Pied Piper 1/ STM Electronics Menlo Park, Ca. Write 358	Z80A	64K RAM 4K ROM 1MB disk drive	CP/M	Perfect Software	AC	\$1299	Thermal printer 5-10 MB disk plotter Modem Video 80 × 24	RS 232 RS 170 parallel port	20 × 10 × 4 13 lbs.	2 line 80 character LCD
Zorba/ Telcon Industries, Fort Lauderdale, Fla. Write 359	Z 80	65K RAM 2, 5¼" disk drives 800K	CP/M	Micropro Digital Research Microsoft Perfect Software	AC/DC	\$1595	Bell 212A Modem 14 selectable baud rates Osborne & IBM PC file interface	RS 232 IEEE 488 RS 170	17.5 × 9 × 16 22 lbs.	7 inch CRT Monochrome 80 × 24 320 × 240 pixels
Teleram 3000/ Teleram Communications Corp. White Plains, NY Write 360	Z-80"L"	128 to 256K Bubble Memory 64K RAM 4K ROM	CP/M 2.2	Teleram Utilities & File Transfer Program	AC/DC	\$4995	RF Modulator 5¼ disk drive with 3 formats expansion chassis	RS 170	13 × 9.7 × 3.5 8.75 lbs.	4 line 80 character LCD
Compact Computer 40/ Texas Instruments Lubbock, Texas Write 361	TMS 70C-20 (8 bit)	34K ROM (OS) 6-16K RAM 128K plug in ROM 48K wafer tape	Basic OS	8 ROM cartridges 14 wafer tapes	AC/DC	\$249 to \$600	Cassette Drive Printer/Plotter	RS 232	9.5 × 5.7 × 1 22 ounces	1 line 32 Character LCD
Portabrain/ Universal Research, Brisbane, Ca. Write 362	Z 80	64K RAM 16K ROM 1, 5¼ 192K disk drive 1, 192K disk emulator	CP/M		AC	\$995 June '83 availability	110 to 19K baud, switchable	2 RS 232 parallel ports	7 × 11 × 3.7 6 lbs.	none

Character Generation Techniques For Dot-Matrix Printers

by Donald E. Holmes

As the need for hard copy data becomes more important for industrial processes, point-of-sale terminals and other related applications, the dot-matrix impact printer is growing in popularity. This is because of its ruggedness, reliability, low cost and the variety of characters and symbols it is capable of producing. The last feature is the most notable. In this article, we will explore some of the reasons why and how matrix printing may satisfy your requirements.

Special Symbols

In the past, special symbols had to be tooled and built into printer hardware. This was very expensive and time consuming. Compounding the problem, if a system needed to be upgraded or changed, artificial limitations were imposed because of additional expense and time.

With the dot-matrix printer, characters and symbols can now be generated through the use of software. It is possible to visualize a word of memory representative of a column of dots (**Figure 1**). Each "one" bit of the word could cause a solenoid to actuate. If several of these words are presented to a moving printhead in the proper sequence and if it is in the right position, firing the solenoids will cause a unique dot pattern to form.

This series of patterns can form letters, numbers, symbols, graphs or pictures—whatever the desired output must be. As jobs or systems change, the printed character set may be changed quickly and inexpensively by altering the appropri-

The versatility of dot-matrix printing allows these printers to be used in a variety of special applications.

ate bit patterns electronically. In an extreme case, these changes can even be made in real time. That is, the character set can be adjusted to fit a new job which may be the result of the previous one.

Printing with a matrix of dots is like generating a hardcopy TV picture. Each character is a pictograph controlled by software. Almost any calligraphic style can be achieved.

Character generation schemes are almost as varied as the individuals creating them. Aside from the obvious esthetics, there are a few mechanical and electrical constraints which may enter into the picture. Mechanical speed, and limited power or memory capacity affect the design. Once the operating parameters are understood, you are free to use your artistic talents to design the dot patterns.

Even the most experienced designers need to engage in some experimentation. When laying out new characters, make the test software as simple and flexible as possible. One point that should be stressed is that the first dot patterns tested will not necessarily look as they were envisioned. Some trial and error is usually required before the ideal set of characters is created.

Mechanical Constraints

As stated earlier, there are always a few mechanical constraints. Probably the single most critical limitation is the speed of the print solenoid. This solenoid has to propel a print pin out to strike the ribbon and print media. Additionally, the pin has to return to a position where it can again be propelled to the media with adequate force. A typical cycle time for an Eaton M-4 Series print solenoid is 1.11 msec.

Standard Eaton M-4 printheads sweep across a 3.33" print area at 12.5 inches per second (ips). Considering this, if all seven solenoids are cycled continuously as the printhead travels across the print area, a matrix of 240×7 dots is available. Breaking this matrix up into smaller units, a set of "typical" character matrices can be derived. If, for example, the common 5×7 matrix (5 dots across by 7 dots high) with one dot space between each character is used, then 40 columns of characters can be printed on each line.

By slowing the printhead travel speed, a denser matrix can be formed by overlapping adjacent dots. In that way, the repetition rate of individual solenoids will not be exceeded. The price paid, of course, is the slower printer throughput. Designers have learned that a matrix, or dot pattern, can be made to look denser by allowing solenoids to print on half dot positions. In other words the matrix is made up of 7×7 dot positions instead of 5×7 . These two types of matrices are compared in **Figure 2**. With the 7×7 matrix, rounded and sloping lines can be printed with much more definition. Printing horizontally adjacent dots will still require 1.11 msec (now two dot positions).

Donald E. Holmes is an Applications Engineer for Eaton Corp., Riverton, WY.

Timing Control

Dot-space timing for the Eaton M-4 can be controlled in two ways: from the timing disk output generating a clock or by a software controlled timeout.

The most accurate method of printing is with the use of clocks. This system physically ties a dot position of the matrix with the position of the printhead. This is accomplished because the printhead is mechanically coupled to the timing disk through the motor and drive gears (**Figure 3**).

The timing disk will generate 4 clock impulses in each dot position. Since there are 240 such positions, the apparent matrix is then 960×7 per line. In actual practice, frequency division is performed by hardware or software to sort out the clocks which are required. Normally, the clock pulses are gated with the left and right margin sensor outputs to indicate the exact field of printing. Because there are 4 clocks per dot position, the registration of the margin can be held to $\pm 1/4$ dot (**Figure 4**).

Software timeout—that is, generating a software controlled delay for both the on and off time of the print solenoid—usually is adequate for most ordinary text printing. This method is possible when there is a constant motor speed. The advantage of this system is that it is usually easier and less expensive to implement. The disadvantage is the slightly inaccurate dot placement caused by variations in printhead speed due to mechanical wear, dirt, etc. Normally, these variations do not show when printing text. If graphics printing is anticipated, this timing method may not be accurate enough.

Optical Considerations

As mentioned earlier, the act of printing is really just drawing pictures with dots. As with a TV picture, the human visual senses integrate the patterns of dots into recognizable units. Optical illusions do occur. This is why experimentation is necessary for good character design. A simple example is the double wide character—one where

1	0	0	0	1	0	0	1	1	1	0	0	LSB
1	0	0	0	1	0	0	0	1	0	0	0	
1	0	0	0	1	0	0	0	1	0	0	0	DATA
1	1	1	1	1	0	0	0	1	0	0	0	WORDS (1 = PRINT)
1	0	0	0	1	0	0	0	1	0	0	0	
1	0	0	0	1	0	0	0	1	0	0	0	
1	0	0	0	1	0	0	1	1	1	0	0	MSB
6	7	8	9	A	B	C	D	E	F	0	1	
F	F	F	F	F	F	F	F	F	F	0	0	BYTE
0	0	0	0	0	0	0	0	0	0	1	1	ADDRESS
1	1	1	1	1	1	1	1	1	1	1	1	

Figure 1: Memory words represent dot column patterns; check the one bits to see the character pattern.

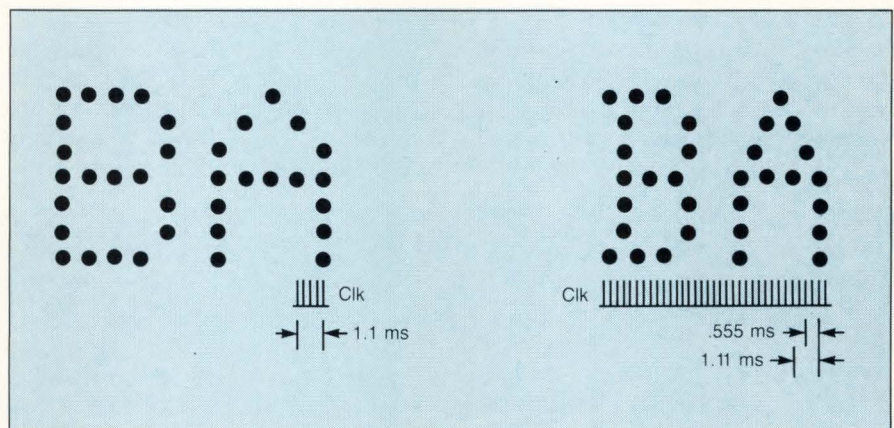


Figure 2: Characters printed with a 7×7 matrix have better definition; rounded and sloping lines are more accurately represented.

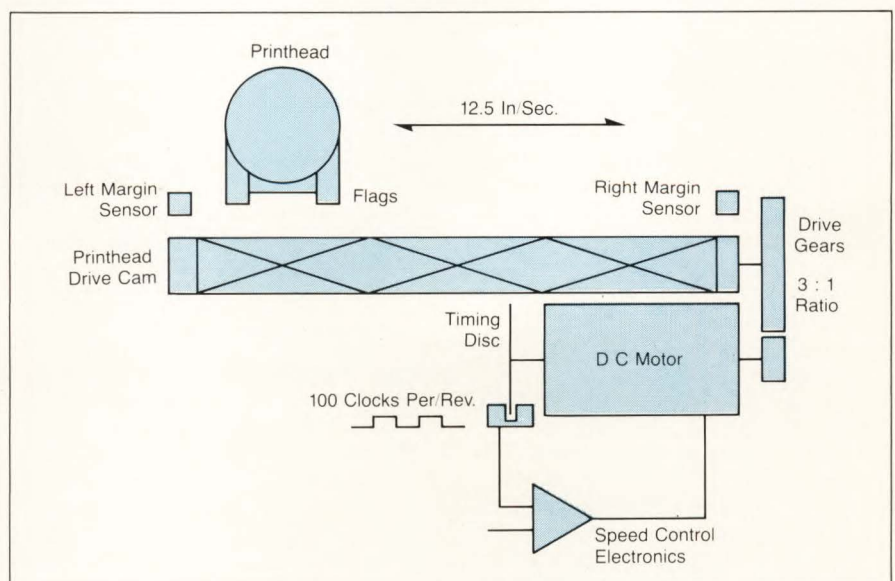


Figure 3: This schematic shows the relationship of the printhead to the mechanism. The printhead is driven back and forth by a helical cam. The cam is coupled to the drive motor through a set of gears. The motor shaft also holds a slotted timing disk. The disk is read by an optical sensor which sends positional and speed information to the speed control electronics and the user in the form of "clocks." Left and right margins are indicated by "flags" on the printhead interrupting optical sensors.

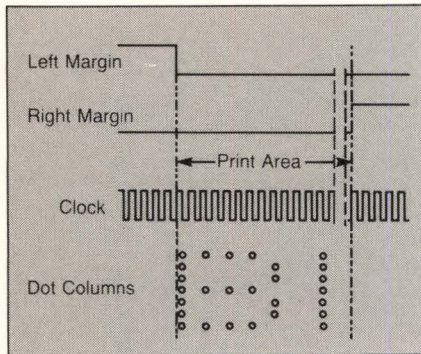


Figure 4: Through the use of the margin and clock sensors, each dot column in the print area is detectable.

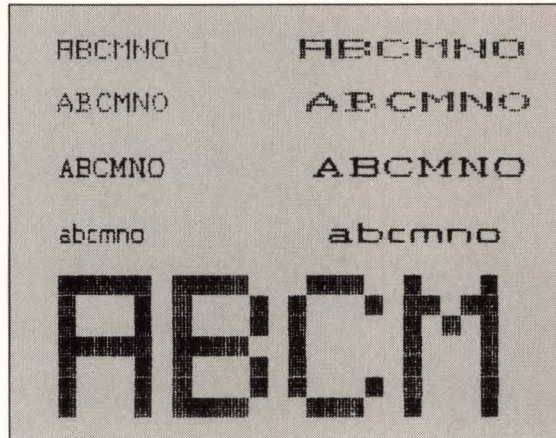


Figure 5: 5 × 7 and 7 × 7 matrices along with their double-wide equivalents are common. Blocks of dots can also be printed to form extra large 5 × 7 characters.

each dot is repeated to form a bold, wider pattern. When observed, the character is not only wider but is perceived to be taller as well, which it is not.

The fact that the eye blends the picture together offers a wide latitude of design parameters. An unattractive, hand-drawn layout may look quite acceptable when print-

ed; however, the opposite is also true. Many times, a seemingly large gap between adjacent dots must occur in order not to exceed the print solenoid limitations. When printed,

When Selecting Printers, Reliability Comes First

In today's character printer market, there are basically two types of products offering similar features and functions. At one end is the more costly premium quality, very reliable printer designed for heavy duty usage, while at the other end there is a low-cost, modest quality printer designed for light usage.

Leasametric Inc, a company that rents, leases and sells printers (as well as electronic test instruments, data terminals and telecommunications equipment) carries printers of both types from five companies: Texas Instruments (TI), Centronics, Digital Equipment Corp (DEC), Hewlett Packard, and NEC Information Systems. Because they are involved with the printers they carry throughout the printers' lives, Leasametric has a unique insight into these printers' reliability, serviceability, and overall cost of ownership. Their observations are as follows:

The TI 820 Receive-Only and Keyboard Send and Receive (KSR) dot matrix printers are highly popular due to their user friendliness and features. These machines print 150 characters per second (cps), have ASCII 128 character sets and are programmable from the keyboard. Their reliability, however, has been marginal. Problems have cropped up with the printing head mechanisms and ribbons, making them better suited for low usage applications.

The TI 810 RO (receive only), better engineered than the 820 models, has performed well and is better suited for medium usage applications. It also prints 150 cps.

The Centronics 353 dot matrix printer's superior reliability has led many customers to replace their TI 820 models with this recently introduced machine. This is a good example where price is overwritten by value. Features include excellent print quality, easy maintenance (estimated repair time is 20 to 30 minutes), snap-in user exchangeable printheads, cartridge ribbons, and serial/parallel inter-

face that makes the 353 suited to universal applications. Although it costs more than comparable machines, the 353 is less expensive to own over the long run, at the same time providing a higher level of on-line time.

Although the DEC LA120 has been a reliable performer, it weighs nearly 180 pounds with the stand, and is therefore less attractive to Leasametric who must often deliver rental printers overnight. In addition, because DEC built the A120's electronics into the stand, it cannot be serviced easily. The machine also has some outdated technology, such as spool ribbons, that customers find unattractive.

Hewlett-Packard's 2631 printer, a popular item in Leasametric's inventory, features high reliability, while offering a low cost alternative to RO machines, especially in graphics applications.

NEC Information Systems Spinwriter series of letter quality printers—the 7710, 7720, 7730 and 7740—feature excellent reliability and solid construction. Both the KSR (keyboard send receiver) and RO (receive only) printers are letter quality and offer a variety of interfaces and options. Well-accepted by users, these machines offer good value.

In summary, over years of owning and providing printers for rental, Leasametric has found that higher cost printers from brand name manufacturers offer the best value for most applications both technically and in quality of support. Lower cost, lower reliability printers have their place in the rapidly expanding hobbyist and low duty usage market and offer many of the same features. But in the long run, lower priced printers can cost more than higher priced printers in lost performance and more frequent repairs. The prudent buyer or renter should not be guided by price and features alone, but should consider the importance of reliability in comparison with the level of usage and lastly, consider cost.

the gap may not only be unnoticeable but may actually enhance the design.

Pitch also has a dramatic effect on the printed characters. It relates to the number of letters, numbers and symbols printed in one inch of printhead travel. This can be controlled by timing. If the time of printhead travel between dots or characters is changed, the pitch will be altered. Minimum solenoid cycle time must always be considered when compressing print.

Referring to the 7×7 matrix in **Figure 2**, notice that the space between letters is comprised of four, 550 μ sec clock times (two dot-spaces). If two of these were not used for the "A", they could be used to start the "B". This would not exceed the solenoid cycle timing and still leave one dot/space between the letters. Effectively then, more characters can be formed in one inch. Instead of 12 pitch, the density now becomes 14.4 pitch; a

40 column printer is turned into a 48 column printer.

Conversely, using this same matrix and stretching the time between dots from 2 to 3 clock times (1.1 ms to 1.6 ms) will widen the letters. By controlling the time between characters as shown previously, pitches of 8 and 9.6, respectively, are available (26 or 32 char./line).

This example illustrates that the flexibility of matrix printing is almost unlimited. Without even changing the bit patterns in memory, different type styles are possible by simply modifying a few timing routines in the software.

Typically, systems incorporating matrix printers use special symbols, varying fonts and other simple tricks to alert an operator. The most common method of printing exception messages is to use the double wide character (**Figure 5**). This is accomplished by printing each dot of the character twice.

Here again, without changing bit patterns in memory, very bold characters can be printed.

Some systems use special symbols. Matrix printing allows a system designer to specify almost anything. If a message is to be flagged, one can draw a flag.

For the programmer with a little artistic talent, designing new fonts for matrix printers is a great diversion. No complex, multi-use algorithms are required. All that is needed is some imagination, a good sense of proportion and the usual amount of patience.

Free ASCII Kit

Eaton offers a layout package for designing ASCII character sets. To receive your free layout of generally used ASCII character sets, hexadecimal coding for dot patterns and special design techniques, use the *Digital Design* reader service card.

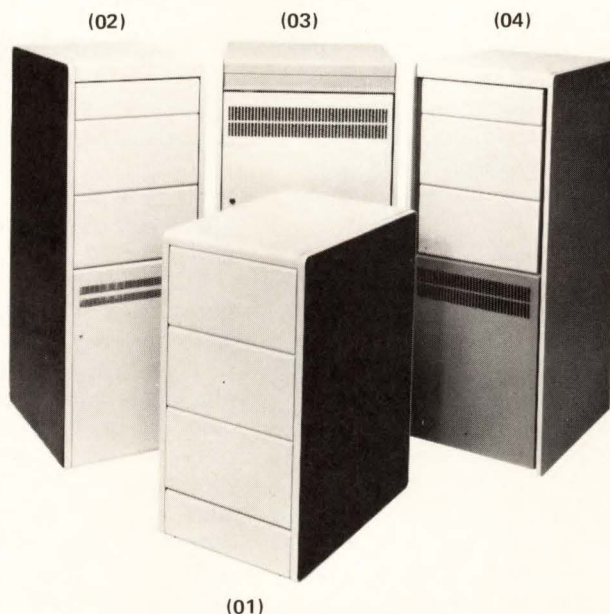
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Write 38 on Reader Inquiry Card

Specifying Uninterruptible Power Systems

by **Richard Caprigno and Gurcharn S. Dang**

When electronic devices and systems do not perform properly, common and frequent AC power problems such as brownouts, voltage fluctuations, transient voltage spikes and noise are often found to be the cause. These problems can be eliminated or at least minimized through the use of line voltage regulators.

Blackouts occur less often, but are particularly troublesome because they cannot be dealt with by regulators. Any power outage, even those lasting only thousandths of a second, are considered blackouts. 50% of all blackouts last six seconds or less. Power companies do not consider a power failure to be a blackout until at least three minutes have passed. But even short outages lasting only 4 ms can damage computer hardware and cause the loss of important data.

Protecting against blackout requires more complex uninterruptible power systems (UPS) that usually represent a significant investment.

The main alternatives available today for protecting electronics from line power disruptions include dedicated lines, ultra-isolation and engine-generators. These devices are not designed for the total power protection that a UPS provides.

Dedicated lines have no capability to regulate voltage or provide isolation and are subject to whatever occurs on the line beyond its point of dedication. Ultra-isolation transformers are designed to suppress transients and prevent line-to-

ground leakage, but allow other serious problems such as transverse-mode noise and brownouts to pass through to the load. Electric motor generators clean incoming power through electro-mechanical inertia, but are not very energy efficient. Constant voltage transformers attenuate electrical noise, clip spikes, provide regulation and protection

Short power outages lasting even as little as 4 ms can cause loss of important data. Protecting against these blackouts requires use of a UPS.

from brownouts—but none of the above can supply emergency power in the event of line failure.

Of course, there are other alternatives that provide standby power. The most common is the gasoline or diesel engine-generator. But engine-generators alone cannot provide "no-break" power unless they operate continually; otherwise, they need two to ten minutes to start up and stabilize. Generator output is often irregular, requiring additional voltage regulation and filtering, and they have the additional expense of rising fuel costs.

In limited applications such as telephone switching systems or other DC-actuated systems, standby battery banks are sometimes used alone as an emergency power source. When a line failure occurs, the power from the battery bank

must undergo a switching process which creates a slight gap in power and electrical noise of its own which could be disruptive to the load.

Most critical electronic loads such as computers, numerical controls, digital instrumentation and μ P systems or lamps such as high-pressure sodium, cannot withstand even an infinitesimal loss in power. Since none of the above alternatives will suffice, these loads must have a UPS for no-break power.

What Is A UPS?

A standard reverse-transfer UPS consists of four major components—a rectifier/charger, a battery bank, an inverter and a bypass/transfer switch. When the AC line is operating, the system protects the load from transients, surges, faults and brownouts. In the event of commercial AC line failure, the system supplies uninterrupted power from the battery bank and continues to provide regulation, isolation, plus transient, surge and fault protection.

Under normal conditions (**Figure 1**), commercial AC line power is delivered to the rectifier/charger stage where it is converted to DC, which charges the battery bank and powers the inverter section. The inverter converts the DC power to AC, shapes the AC sine wave and regulates its voltage, and provides clean AC power through the transfer switch to the critical load.

If the AC line fails or drops too far below nominal voltage ratings (**Figure 2**), DC power continues to be supplied to the inverter by the battery bank. Since DC voltage is always present at the inverter input, there is neither a time delay nor switching involved in the process. Therefore AC output to the critical load is uninterrupted and unaffected by AC line variations or failures.

Richard Caprigno is UPS Marketing Manager and Gurcharn S. Dang is Director of Engineering at Sola Electric, a unit of General Signal, Elk Grove Village, IL.

The bypass/transfer switch is a further precaution to protect the critical load. In the unlikely event of inverter failure, or if the load demands an input surge during the availability of commercial AC line power, the automatic transfer switch will connect the load directly to the commercial AC source via a separate bypass line (**Figure 3**). Upon restoration of acceptable inverter output, the transfer switch will return the load to the UPS. These components will be explained later in more detail.

Rectifier Tolerance Important

In most UPS models, the rectifier is designed to provide sufficient power to the load and keep the battery bank charged. Input voltage variation is the key variable—some UPS rectifiers will continue to charge the batteries and power the critical load despite an input line voltage drop as low as 20% below nominal in small systems (below 15 kVA) and 15% in larger systems. These brownout protection capabilities offer a good point of comparison because they differ between manufacturer and kVA rating. They are important because blackouts commonly follow prolonged brownouts; the UPS with better input brownout tolerance does the better job of delivering full battery reserve when the blackout occurs.

Most UPS designs also incorporate an AC walk-in feature in the rectifier stage, which allows the load to be gradually applied to the AC line during startup, or when AC power is being restored after a failure. This walk-in feature prevents current inrush that could trip line fuses or other input protection devices.

Some UPS designs incorporate tuned tank circuits and multiple pulse rectifier circuits to minimize harmonic feedback into the primary line. This minimizes interference to other sensitive equipment on the AC line. In addition, some rectifiers have enough filtering at the output to allow the inverter to operate directly off the rectifier with the battery disconnected, which is useful when servicing the battery bank.

After a line failure has occurred,

batteries that supplied standby power must be recharged by the rectifier while it simultaneously powers the inverter. Battery recovery or recharge rates are expressed differently by UPS manufacturers. Most recovery rates are expressed relative to discharge time, but some UPS units also list minimum recharge times ranging up to eight hours. Recharge times based only on minimums can be a disadvantage. If, for instance, a battery discharge lasts two minutes, an eight-hour recharge is a long recovery time. However, if the recovery rate is 8–15 times the discharge rate, then full recovery takes only 16–30 minutes. Since most power outages are short in duration, 8–15 times the discharge time is a fast, practical recharge rate.

Batteries Determine Output

Batteries, which determine the time reserve of the UPS output, of-

fer two basic choices—wet or gelled cells. Wet-cell batteries are available in nickel-cadmium or lead-acid types. Nickel-cadmium types are generally considered too costly for UPS applications. Lead-acid batteries may be either lead-calcium or lead-antimony types with lead-calcium being the most widely used today in UPS units. Having practically replaced lead-antimony types in new installations, lead-calcium batteries are preferred because they use less water which means less maintenance. Lead-calcium batteries also require a lower floating current.

Gelled-cell batteries are considered maintenance-free because they use an immobilized electrolyte instead of a wet electrolyte. Gelled batteries are generally used in tight, restricted areas where wet-cell maintenance would be difficult.

Typically battery suppliers provide a variety of battery racks in-

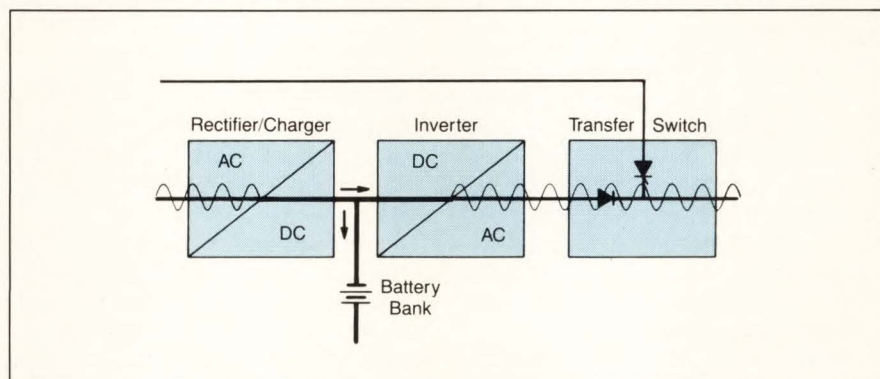


Figure 1: Under normal conditions, the commercial AC line delivers power to the rectifier/battery charger (AC to DC conversion) section of the UPS.

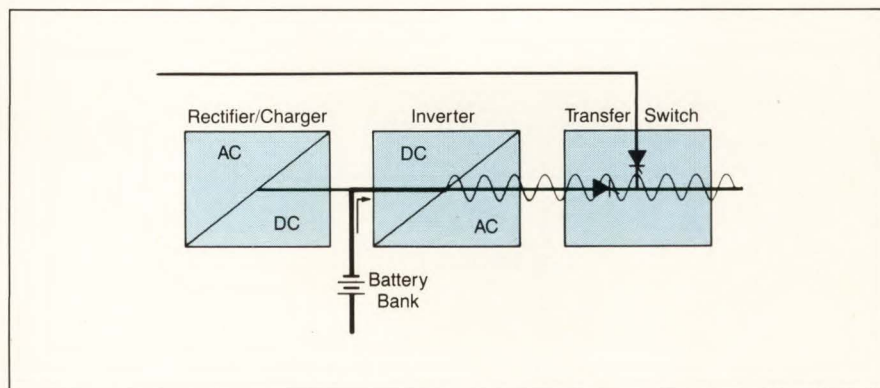


Figure 2: If the AC line fails or drops more than 20% below normal, DC power will continue to be supplied to the inverter section by the battery bank.

cluding two- or three-tiered arrangements. The floor plan and area in which the UPS and batteries are to be located will dictate rack size and type needed.

Specifications in regard to how much physical plant space the UPS and batteries will occupy should take into consideration the combined weight of the two. Because of the battery construction—lead plates, electrolyte and racks—the battery bank will weigh more per square foot than the UPS circuitry cabinets. The UPS cabinets and the battery bank need not be in the same room, but it is generally advisable to keep them in general proximity of one another, both to minimize wiring and installation costs. The reserve time you need depends upon the application or situation for which the UPS will be used. Five to ten minutes of reserve time is usually recommended to allow a generator to be brought on-line after a failure. Where an orderly shutdown is desired, 10 to 30 minutes is recommended, depending of course upon the particular application or manufacturing process being protected. Up to 90 minutes is recommended when the application calls for the UPS to carry the load through a line failure. A 90-minute reserve also complies with OSHA standards for battery-powered emergency lighting.

Batteries can be supplied for several days worth of standby power, but aside from being impractical from the standpoint of bulk, an oversized battery bank could never

be recharged fast enough to be practical for most applications.

All wet batteries under certain conditions can generate noxious gases; therefore, sufficient ventilation should be provided to the battery room. Generally, if the battery-room air is changed at least once daily, there should be no problem with accumulated battery gases. Basic safety facilities and equipment also should be installed in the battery room, especially when using wet-cell batteries. These include such basic precautions as a posed and enforced smoking ban, fire extinguishing equipment, gloves, goggles, and an eye wash or shower. Batteries are designed to operate in a rated 26° C ambient temperature. Colder ambients reduce battery efficiency significantly and high ambients reduce battery life. Keep this in mind when determining the battery bank location so you can obtain the maximum life and performance from your batteries.

Inverter Reshapes AC Wave

The heart of the UPS is the inverter, which converts DC power from the rectifier or battery bank into AC power.

The inverter is required to produce constant regulated output AC voltage even though the DC input varies considerably when the battery is supplying power. Various pulse-width modulation techniques are available to control the magnitude of this output voltage. Another, more basic technique is to

use a ferroresonant transformer. UPS units are usually categorized by the type of inverter used.

The technique used to regulate the output voltage affects the harmonic content of the AC output. In pulse-width modulation inverters, the output-voltage waveform is nonsinusoidal and must be filtered to reduce the total harmonic distortion to within an acceptable limit (usually 5%).

Of the various pulse-width modulation techniques available, the most commonly used are: (a) single-pulse modulation; (b) multiple-pulse modulation; (c) sinusoidal-pulse modulation; and (d) true harmonic-reduction pulse modulation. In addition to pulse-width modulation, the outputs of several inverters may be combined by transformer connection to form a step-wave. With this approach, the individual inverter waveforms are shifted in phase such that specific harmonic components are virtually eliminated.

Pulse-width modulation inverter circuits basically consist of SCR's that are switched on, and then forced to shut off, thereby producing an oscillating power waveform that is modulated and filtered. The techniques employed in commutating (shutting off) the SCR greatly influence the kind of pulse-width modulation technique that may be used and the resulting efficiency.

Among the newest and most efficient pulse-width modulation inverter designs available today is one employing impulse current-commutation to shut the SCR's off, single-pulse width modulation to control the output voltage, and dual phase shifted transformer-connected (step-wave) inverters to reduce the harmonic content to less than 3% total harmonic distortion.

This inverter design, although quite complex, also results in extremely good output dynamic regulation (due to minimized output impedance) and overload capabilities.

The other major method to change inverter DC to an acceptable AC output waveform is built around a ferroresonant constant voltage transformer (CVS). A CVS

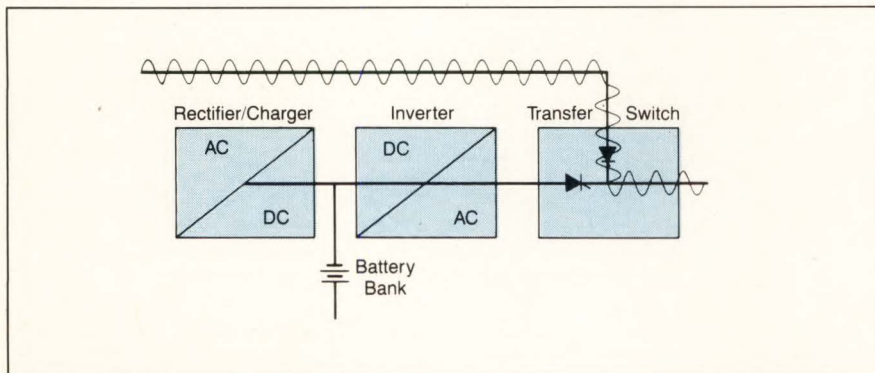


Figure 3: If the system is overloaded or malfunctions during availability of the commercial AC line, an automatic transfer switch will bypass the UPS and connect the load directly to the commercial AC source.

in the inverter is simple, reliable and practical in low output ranges, no higher than 15–30 kVA, but due to its size limitations and low operating efficiency in larger kVA ranges, the CVS becomes impractical in larger systems.

UPS units that incorporate ferroresonant transformers in the inverter offer the advantages of achieving excellent voltage regulation without the need for feedback circuitry as required in pulse-width modulation designs. These ferroresonant transformer designs inherently provide a sine wave output with less than 5% maximum harmonic distortion, which is ideal for sensitive computer applications. They do not need additional filter circuits.

Regardless of which inverter design is used, certain desirable performance characteristics of the inverter include voltage regulation of $\pm 5\%$ or lower and dynamic regulation of $+10 - 8\%$ or better. Other attractive benefits that are available include automatic voltage line drop compensation, adjustable AC output, and precise frequency tracking of the bypass line.

The most important inverter performance feature is the UPS's operating efficiency. Efficiencies, however, differ between manufacturer, design and kVA rating. New UPS designs can achieve efficiencies of up to 90% in the large 100–150 kVA models.

Automatic Transfer Switch

The fourth and final section of a UPS is the automatic transfer switch, which determines whether system output will be drawn from the inverter or the commercial AC bypass line.

Standard UPS units are equipped with a solid state transfer device that can switch from inverter to bypass fast enough to accomplish a "no-break" transition. To do this, the inverter must have circuits to make sure that the AC wave produced by the inverter is synchronous with and phase-locked to the AC wave of the bypass line. If a transfer is caused by inverter failure or is manually initiated, the solid state switch will be locked on

bypass and must be manually retransferred.

If the critical load is able to withstand up to 50–100 ms transfer time, an electromechanical transfer switch is available and may reduce the system's cost.

Important Considerations

One of the first things to determine when specifying a UPS is the system's kVA size rating. A general rule of thumb is to let the load, or protected device or equipment, dictate the kVA rating. For instance, if a CPU is being protected by the UPS, are its accompanying card readers, terminals and printers to be protected also? If so, the collective power they all draw should be included in the total kVA rating.

Not only should total operating current of the protected equipment during normal operation be considered, but also the power needed at start-up. In most circumstances, not all of the CPU's peripherals would be started at the same time, but it must be taken into consideration nonetheless.

Emergency lighting is another possible add-on to the total kVA rating. If the UPS is intended to "bridge the gap" until an engine-generator is brought on-line and running, then emergency lighting may not necessarily have to be under UPS protection. If the lighting is high-pressure sodium, which cannot restart immediately, UPS protection may be essential.

When the UPS is used to carry the load in order to effect an orderly shutdown, then minimal lighting should be included for safety.

To keep UPS costs as low as possible, make sure the total kVA figure excludes anything, such as air-conditioning, that can wait for a few minutes until a generator takes over or until commercial power is restored.

The AC input service line should carry approximately one and one-half times the total UPS kVA rating. This is required because following a line failure, the UPS must draw enough line power to satisfy the load and recharge its battery bank simultaneously. Your service line's voltage, amperage, frequency

and wiring configuration should be written into your specifications. Also add the minimum power factor and harmonic feedback that the rectifier will present to the AC line, as this will affect both your input current and other equipment in your facility.

Along with total kVA, you need to determine the length of battery time required. If the kVA total reaches 50 and the desired standby time needed from the battery bank reaches 90 minutes, a cost tradeoff usually arises between additional batteries and an engine-generator. To go beyond this 50 kVA–90 minute mark, it may be less expensive to add an engine-generator set to back up the UPS, and cut down the size of the battery bank as necessary.

If an engine-generator is used in conjunction with a UPS, the UPS is typically positioned between the generator and the critical load. This way, the generator's output is sent through the UPS where it benefits from UPS regulation, isolation, waveshaping and noise-attenuating capabilities, and also begins recharging the UPS batteries.

Another key part of this type of combination system is an input transfer switch, required to connect the generator output to the AC line that provides UPS input. Input transfer switches are available which wait up to five minutes to determine if the AC line failure will last long enough to merit generator start-up, or can be set at predetermined times to "exercise" the generator for a couple of hours on a weekly basis.

Conclusion

New, more efficient UPS designs are continually being introduced to the marketplace. Besides the total package cost, always consider the features and capabilities of various models and make before purchasing your UPS equipment.

With more and more brownouts and blackouts in the forecast for the 1980's, the uninterruptible power system can pay for itself many times over as a safeguard for any critical load. □

Modular Graphics Terminal Uses Multiprocessor Architecture

Changing technology and a lack of established standards at the device level have created problems for the OEM designer using graphic displays. OEMs requiring graphics have traditionally had to choose between two generic product offerings: turnkey terminals or dumb board level controllers.

The board level solution, while relatively inexpensive on the hardware side, is becoming impractical in many low volume applications due to the software development costs. Today's graphic controller boards are extremely complex, utilizing dozens of control registers, as well as sophisticated VLSI graphics controller chips. Typically, a team of highly specialized software engineers is required to write the code necessary for driving a graphics board.

The turnkey solution also has its drawbacks. It can be expensive, especially in volume applications. Without true device level standards, there is potentially a problem of being locked into a particular manufacturer's software protocol. Also, the OEM may be forced to use the terminal manufacturer's keyboard, monitor and cabinetry, which might not fit into the company's total system design concept. The complete terminal solution may also be unacceptable to the OEM who wishes to upgrade existing installations of equipment with a state-of-the-art

high resolution color terminal. His investment in host-level software is usually massive, and his terminal driver routines may not be available in source form or they may be embedded in so many places that it is impractical to rewrite the drivers for a new terminal.

GX Family

The GX family of graphics products allows the OEM to choose several additional levels of product integration between a turnkey system and a dumb board. The line was designed to meet the display requirements of a wide range of OEMs, including manufacturers of CAD/CAM systems, engineering workstations, process control equipment, medical electronics, and teleconferencing systems.

The high end member of the family is a turnkey terminal, the GXT-1000. The terminal features include: a resolution of up to 1280×1024 pixels; 4 to 16 planes of video memory; multiprocessor architecture; complete 2D transformation software; multiple viewports; drawing speeds of up to 5000 vectors per second; $64K \times 64K$ virtual addressing; local segment memory; and extensive local I/O support. The hardware and software organization of the terminal is shown in **Figures 1 and 2**.

The terminal comes with a 19"

high resolution color monitor, a low profile detachable keyboard, display electronics, and a low profile Multibus desktop or rack-mount enclosure with integral floppy and Winchester disk drives. In keeping with the "building block" philosophy all of the GXT-1000 components (monitor, keyboard, cardcage, Multibus boards, and software) are available unbundled to suit different levels of OEM integration requirements.

Display Processor

The display processor is a Matrox GXB-1000, (see *Digital Design* Oct, 82, "Graphics Board Gets Intelligent"). The display processor interfaces with the main graphics processor via a display file (using absolute screen coordinates) stored in common RAM on the Multibus. The GXB-1000, which contains 4 dedicated graphics CPUs, executes a powerful instruction set which provides for surface and subsurface visibility and priority; vector, point, arc, circle and character drawing; cursor and marker generation; tracking, inking and rubber banding; look up tables, raster ops and area fills.

The GXB-1000 also includes the image buffer. The buffer memory, which can be up to 2 Mbytes in size, is partitioned into $1024 \times 1024 \times 4$ bit sections, each occupying a separate Multibus board.

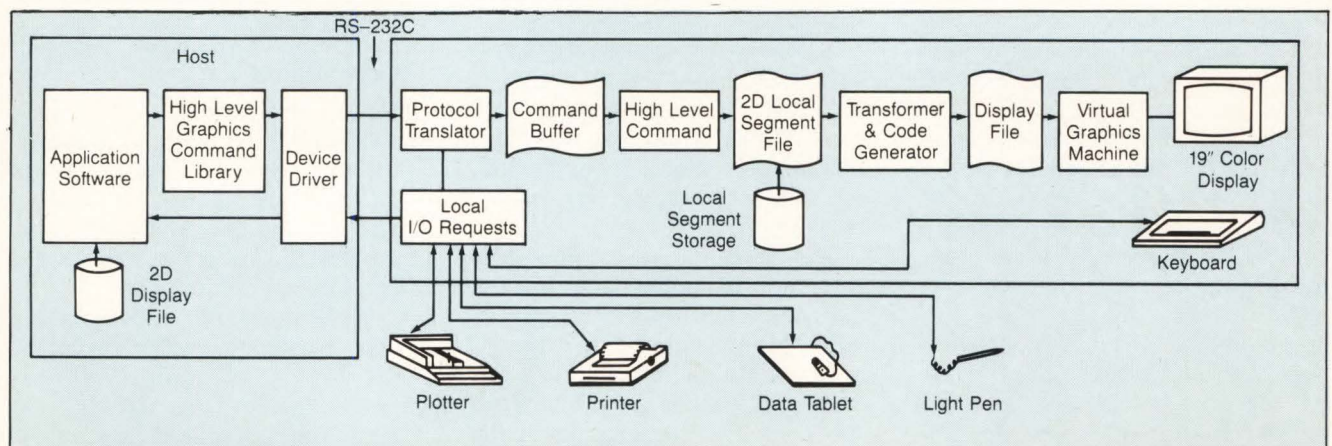


Figure 1: GXT-1000 Multiprocessor hardware organization.

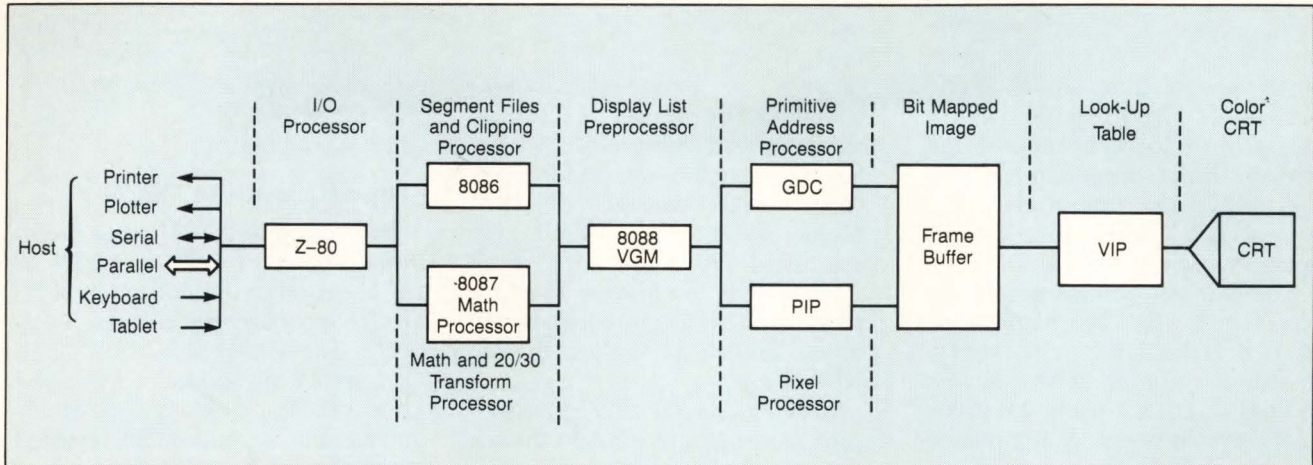


Figure 2: GXT-1000 software organization.

The GXB-1000 provides the OEM with a smart graphics board solution. He need not concern himself with bit bashing at the raster level, but he still has the freedom to select any in-bus host CPU and software.

Graphics Processor

The main graphics processor is an 8086 CPU with an 8087 floating point co-processor. The processor board, which holds 128 Kbytes of EPROM program memory and 128 Kbytes of dynamic RAM segment memory, contains a real time operating system for multiple task scheduling. These tasks include dynamic memory management, high level graphic command interpretation, 2D transformations, clipping, windows and viewports, and data tablet and light pen I/O. The 8087 floating point processor provides the number crunching power required to perform fast rotations, translations, and clipping. Picture data specified in virtual coordinates can be completely transformed at rates of up to 5000 vectors/second.

The object to be displayed, be it the layout of a circuit board, or the frame of an automobile, is described by a series of points, lines, circles, etc. Objects are described in "virtual" co-ordinate space. Virtual addresses (x, y values) are defined using 16 bit data words, thereby offering 64K × 64K re-

solvable points. In many applications this offers significant performance improvements over the 12 bit data words (4096 × 4096 address space) associated with older terminals.

Consider the case of a circuit board manufacturer who requires a minimum resolution of .001" to define the traces and pads used on his boards. If the virtual co-ordinate unit is set at 0.001", then in a 64K × 64K space, boards of up to 5' × 5' can be defined. A 4096 × 4096 space would only allow for board sizes of up to 4" × 4". Similarly, in computerized drafting applications where 200 dots per inch is an acceptable plotter resolution, drawings of up to 27' × 27' can be defined in 64K space, as compared to 20" × 20" in 4K space (D size drawings are 17" × 34").

The significance of the lack of adequate resolution in the terminal is that the complete object must be kept in host memory and each time the user wants to see a different part of the object (pan or scroll it), the *host* must do the windowing transformations and clipping and resend a picture to the terminal. To make full use of the large virtual addresses, picture segments must be stored locally. Even though segments have traditionally been supported at the host CPU level, many manufacturers (including Tektronix and

Hewlett Packard) have introduced devices that support local segments. Local segments allow the user to download an entire object, defined in virtual coordinates, to the terminal. All 2D transformations (rotation, scaling, translation), zooming, and panning, can then be performed locally without retransmitting the picture file. This feature greatly reduces host communications overhead, and speeds up system throughput.

The GXT-1000 uses 128 Kbytes of RAM to store picture segments, and this can be augmented with an additional 512 Kbytes of RAM or local 5¼" floppy/Winchester disks (providing up to 21 Mbytes of local picture storage).

Because segments are stored in local memory, all windowing can be performed at the terminal level. Virtual "windows" determine what portion of the object data base is to be displayed. Expanding or contracting the size of the window provides a zoom function. Similarly, by shifting the window from right to left or top to bottom, the data base can be panned and scrolled. The GXT-1000 supports up to 64 simultaneous windows, allowing the operator to display several different views of the same object.

Associated with each virtual window is a screen window, or viewport, which determines what portion of the physical display is

to be occupied by each window. In addition to the graphics viewports, up to four alphanumeric viewports (high speed dialog areas) can also be defined on the screen. Dialog areas can be used for displaying foreground and background task status, menus, operator prompts, etc.

The graphics processor card executes high level command files, (using virtual co-ordinates), stored in common RAM on the Multibus. OEMs using Multibus based systems can communicate directly with the graphics processor from their in-bus host. The combination of the graphics processor card and the display processor (GXT-1000) provides essentially a complete terminal on 3 Multibus boards.

Communications Processor

A separate Z-80-based processor card is used to handle all commu-

nication between terminal and host, as well as I/O to local peripherals. A Serial RS232C/423 communications port is used to communicate with the user's host. Several synchronous and asynchronous protocols including IBM bisync, HDLC, and SDLC are supported. A bidirectional 8-bit parallel port can also be used for block data transfers between terminal and host at up to 330 Kbytes/sec.

Resident on the I/O processor card is a software module known as a protocol translator. The protocol translator interprets the ASCII data sent from the host, transforming it into "standardized" high level graphics commands that can be executed by the graphics processor. The standardized commands are stored in a buffer located in common Multibus RAM. By implementing different translator software, the

GXT-1000 can emulate many different graphics terminals (the standard protocol recognized by the GXT-1000 provides Tektronix 4113 compatibility).

High Resolution Display

High resolution RGB color monitors capable of displaying 1024×1024 pixels non-interlaced at 60Hz have only recently become available. The Mitsubishi C8912 monitor, which can support a displayed resolution of 1024×768 at 50/60Hz, can be optionally supplied with the GXT-1000. The standard monitor, a Mitsubishi C6919, will support resolutions of 1280×1024 at 25/30Hz, 1024×768 at 25/30Hz, or 640×480 at 50/60Hz. Monitors from other manufacturers, including Hitachi, Conrac, and Ikegami, are also compatible with the terminal.

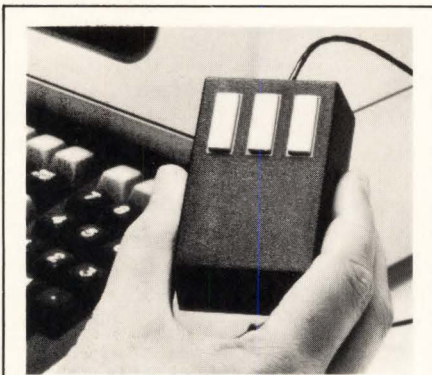
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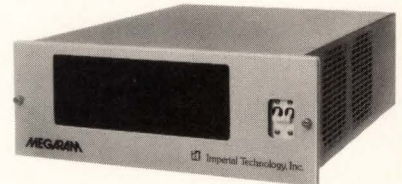
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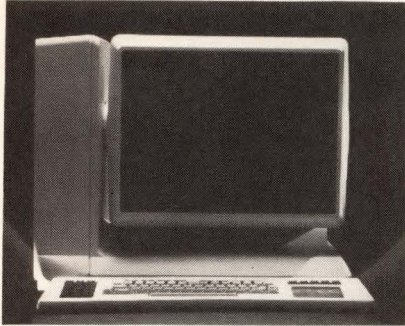


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Apollo Introduces Engineering Workstation



The DN300 is a 32-bit, virtual memory central processor with a half Mbyte of main memory. The 17", high-resolution bit-mapped graphics display supports multiple windows; a low-profile, detachable keyboard; an interface to the 12 Mbit/sec. Domain local area network; and Aegis, Apollo's network-wide virtual memory operating system, at a cost of \$10,000 in quantity.

Options include main memory expansion up to 1.5 Mbytes, dis-

kette and/or 34 Mbyte Winchester hard disk drives, and a touchpad cursor control.

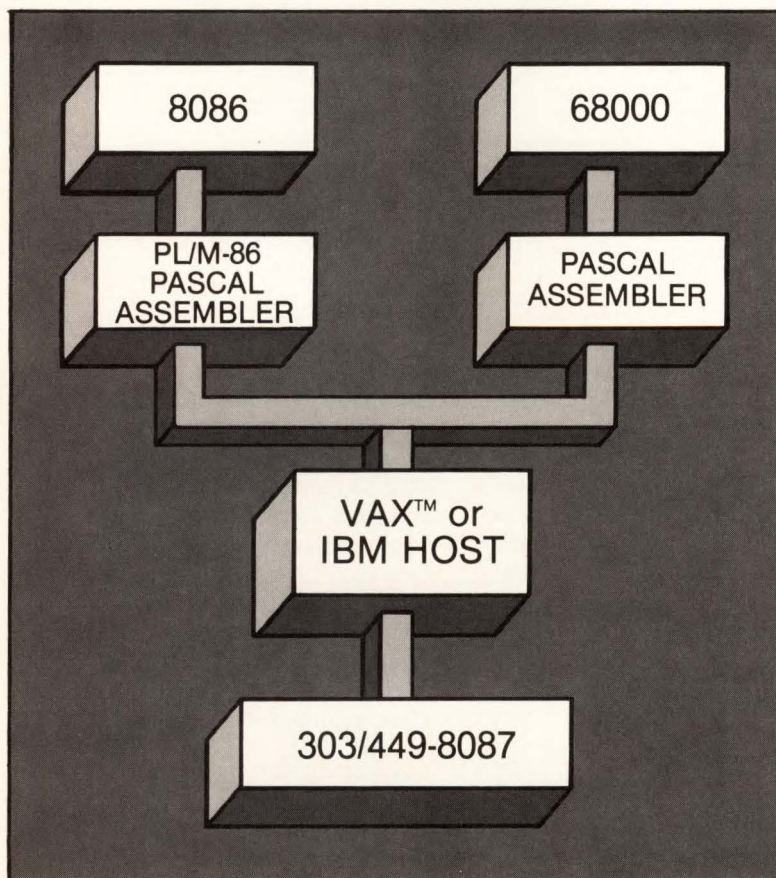
Compatible software includes Fortran 77, Pascal, and "C" programming languages, as well as AUX, a software environment based on UNIX System III. The DN300 is fully compatible with Apollo system software, including the Aegis network wide virtual memory operating system, the Domain Distributed Data Management system (D3M), SIGGRAPH Core graphics library, and X.25, HASP, and 3270 communications subsystems.

The graphics display is a landscape-oriented, 17", diagonal black-and-white monitor with 1024×800 pixel resolution, using bit-mapped raster-scan technology. A dedicated 128 Kbyte dual-ported display memory performs interlaced refresh at 80 cycles per second and features a block-trans-

fer rate of 12 Mbits/sec.

The Domain network interface features a 12 Mbit/sec. baseband data rate using self-synchronizing, hardware "bit stuffing" techniques, a ring topology, and token-passing arbitration. The network interface can transmit to another specific node or can broadcast a message to all nodes on a Domain network. Active nodes can be as much as 3,280 feet (1,000 meters) apart; commonly available RG6/U 75-ohm coaxial cable with BNC-style twist-lock connectors is used for network communications.

Two separate RS-232-C ports provide independent, software-selectable transmission rates from 50 through 19.2 Kbits/sec. with X-ON/X-OFF transmission control capability. DN300 nodes also feature software support for personal peripherals such as graphic tablets and letter quality printers.



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True Memory Sharing For VAX, LSI-11 & PDP-11 Computers

Computer users have long sought ways to effectively share memory between computer processors in order to permit dual CPUs performing multiple tasks to use common data. In the past, these memory sharing techniques have had several drawbacks which limited their practicality, both in terms of increased cost and in implementation problems.

One of the early methods for memory sharing was the DMA (direct memory address) link. This form of link interconnected the buses in two CPUs but, because of its nature of operation, required an important level of software support. Software drivers had to be provided for each end of the DMA link and interfaced through the operating system of each of the CPUs. Consequently, access speeds were slowed due to the requirement for data transfer. Some higher speed DMA links have been developed in recent years but as data transfer speed goes up, so does the cost of the link.

Another method of sharing memory is dual ported memory. A drawback of dual ported memory is the difficulty in resolving access contention problems; also, most dual ported memory has no interrupt capability, leaving communication between the processor to polling. Memory capacity is limited and the types and mix of computers which can be connected by dual ported memory are also limited. For example, a mixture of Unibus and Q-Bus computers is not supported.

A New Technique

The drawbacks of these earlier generations of memory sharing techniques have been eliminated in a new peripheral processor link. The PPL-2 incorporates new hardware and software modules that may be used with a wide variety of computers made by Digital Equipment Corp. It can be used

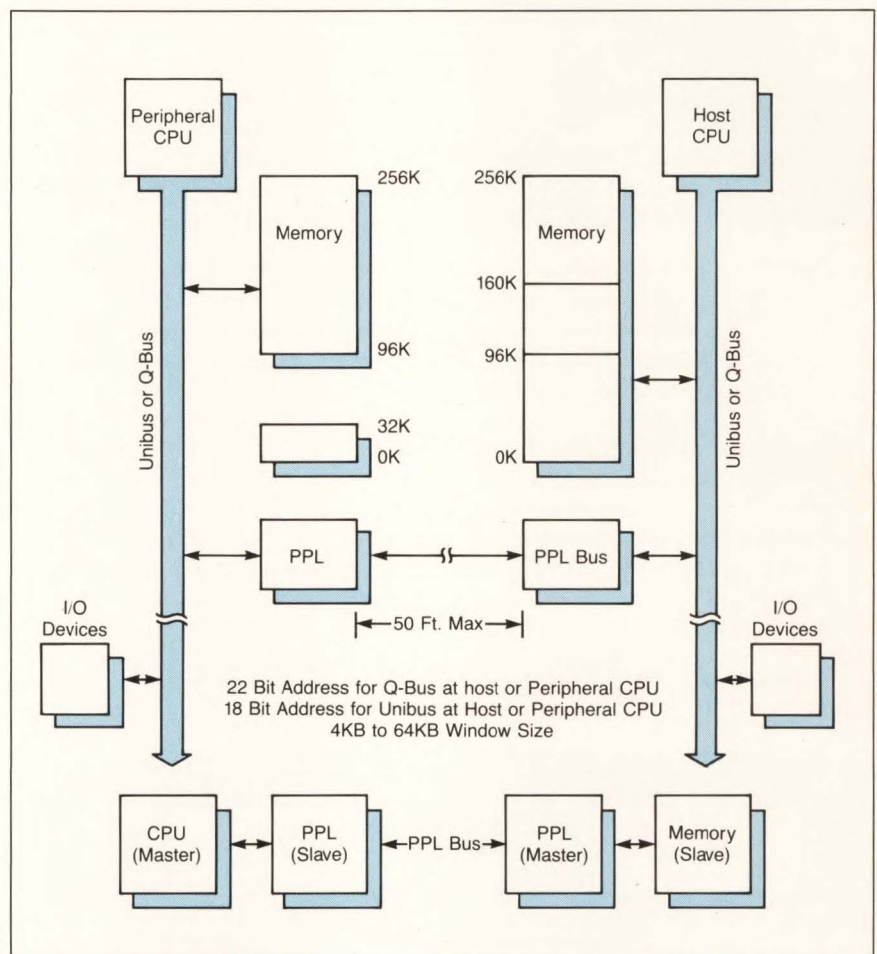


Figure 1: This diagram shows a typical PPL-2 installation between a VAX and either an LSI-11 or PDP-11.

to connect any LSI-11 Q-Bus computer or any PDP-11 Unibus computer with any VAX-11 computer, from 11/730 to 11/780.

The PPL-2 incorporates two quad height logic boards, one to reside in the backplane of each computer, connected by a 50-conductor ribbon cable (Figure 1). The board in one CPU is specified as the host and the other as the peripheral processor. In addition, a specially-developed VAX/VMS driver module is used to link the VAX Unibus to other Unibus or Q-Bus computers. It presents user processes with a series of contiguous physical address locations (device registers) in the VAX pro-

cessor I/O space.

The PPL-2 hardware logic essentially creates a memory "window" that lets the peripheral CPU access up to 64 Kbytes of host memory as if it were its own. The host processor supports the actual physical memory that will be shared. There must not be any physical memory at the shared window location in the peripheral processor because the PPL interface occupies that logical space.

The PPL-2 differs from dual ported memory devices in that there is no memory resident on the PPL-2 itself. Also, unlike DMA links, there is no requirement to set up data transfers.

Each of the PPL boards represents just one unit load per system bus. A total of 16 vectored interrupts eliminates polling requirements and provides the means for implementing communications protocol between the two computers if an application requires it. The same interrupts may be used for "watch dog" prodding in the event of a need for so-called hot backup.

Real-time VAX/VMS processes are given the choice of either using the VAX/VMS I/O system to perform input-output operations or of bypassing most of the I/O system by manipulating device registers and responding to device interrupts directly. When the latter approach is used—which is available only on the VAX-11/780—the protection functions that VAX/VMS normally performs are eliminated. No checks are performed to insure that no other VAX/VMS processes are mapped to a page and modifying it, and no reference count is maintained so that a process can delete a global section while other processes are still using it.

The Unibus adapter developed for the PPL-2 performs the actual mapping of VAX virtual addresses to 18-bit Unibus addresses that correspond to device registers. It controls I/O operations by performing a number of functions transparently for the user.

For example, it defines the PPL for the rest of VAX/VMS and it defines the driver for the system procedure that both loads the driver into virtual address space and creates the associated data structures. It also readies the PPL-2 for operation at system startup and during recovery from a power failure. It performs device-dependent I/O preprocessing and it translates programmed requests for I/O operations into device-specific commands.

The driver activates the PPL-2 and, in operation, responds to hardware interrupts generated by the device, responds to device timeout conditions and responds

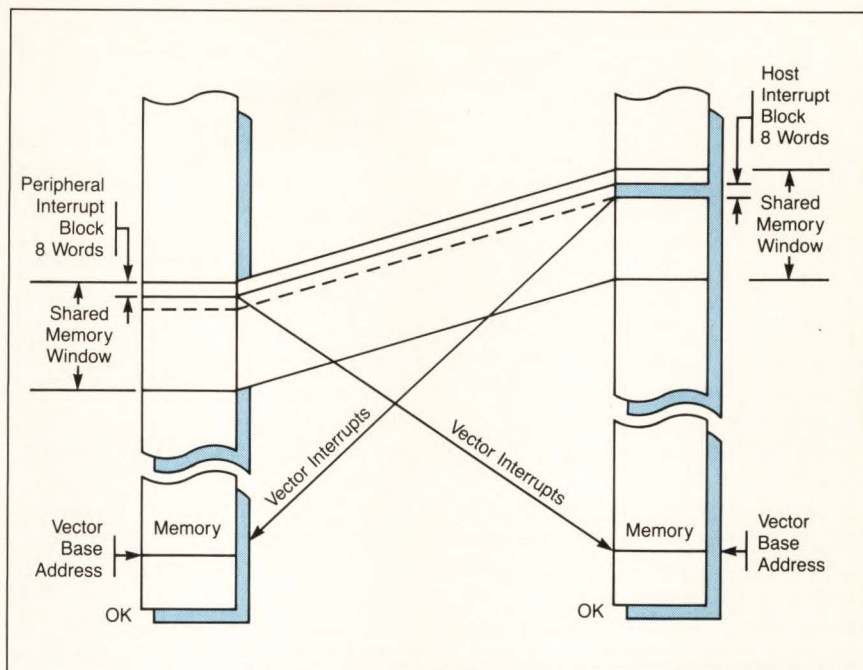


Figure 2: The 16 last words of the shared memory are monitored for access. Above are the typical vector address locations in the system.

to requests to cancel I/O on the device. It also returns status from the device to the process that requested the I/O operation.

Theory Of PPL Operation

Each of the PPL-2 logic boards fit into a single quad height SPC slot on the backplane of each of the computers. The host and peripheral processor designations are made using pencil switches on each board. On the host side, the interface behaves like a DMA controller which can operate on its own, without CPU intervention. The interrupt control and level are the same as would be found in any standard interrupt device.

The amount of host memory which can be shared is variable up to a maximum of 64 Kbytes, in 4-Kbyte increments. The position of this window is variable as well and is selectable via pencil switches for either port, also in 4-Kbyte increments.

Because there is no physical memory at the window location in the peripheral processor, when a reference to share memory is

made on that side, the PPL answers as if it were memory. It simultaneously claims bus control at the host side, translates source address at the host side, and completes a memory cycle. All memory cycles are supported, thus making it possible for the peripheral CPU to execute code out of the host CPU's memory.

Since all shared memory is located in the host CPU, when a reference to shared memory is made at the host, the CPU simply completes a memory cycle within its own memory.

The sixteen last words of the shared memory are monitored for access, eight words for the host and eight for the peripheral processor (Figure 2). This 16 word block is located at the top of the shared memory. READ and WRITE operations can occur just as they would in any other memory location, but they can also be used to trigger an interrupt to the other processor. This mechanism will avoid polling and provide the user application programs with a set of interrupt that it can control.

An understanding of the bus cy-

cle required to execute an instruction is needed if users wish to employ the interrupt mode selectively. Users can selectively generate interrupts using a READ cycle, a WRITE cycle or both. Or they can disable them and not generate any interrupts. Using the PPL-2, a READ MODIFY/WRITE cycle may be generated to issue an interrupt on READ and WRITE (only one interrupt per instruction) regardless of the interrupt mode selection. This can be important to users whose older systems still use core memory.

An interrupt stack keeps track of the interrupts requested by either the host or the peripheral CPU. A sequence can trigger two or three interrupts, up to a maximum of eight, without having to give time to the other CPU to respond. The PPL logic keeps track of all interrupts as if in a holding pattern, then unstacks the interrupts so that none are lost. The interrupt stack works in both di-

rections—host-to-peripheral and peripheral-to-host processor. An INIT and RESET instruction handles the initialization function at the local board and clears the interrupt stack at both sides of the link so that no interrupts are pending from either side after initialization.

Intelligent Monitor & Control

The PPL link provides an intelligent throttle control feature which prevents the Q-Bus or Unibus from being tied up by the PPL. When throttle control is enabled, the host PPL constantly monitors the bus activity. If the PPL is active and another DMA device wants access to the bus, the host PPL will relinquish the bus as quickly as is feasible. The PPL will throttle the peripheral for the length of time the user specified by four jumpers (TR1, TR2, TR3 and TR4), thus enabling the host CPU to attend to other devices without getting bogged down. The

user thus can pre-select the number of bus cycles permitted as a maximum for any device, as well as specify the time interval between bus cycles so that no single device can control the bus indefinitely.

The intelligent throttle works on the principle that any device may use the bus as long as required provided that no other device needs the bus. If throttle control is active but no other device wants access to the bus, the PPL will access the bus at its own speed.

In addition to the sophisticated monitor function of the throttle control, the peripheral PPL-2 also monitors the power supply. In the event that a power supply problem develops, the PPL link finishes any shared memory cycle which may be in progress and then prevents the issuance of any other cycle until the power supply unasserts ACLO or BPOK.

Implementation Flexibility

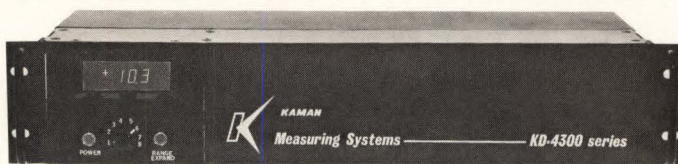
The PPL-2 link has been designed to provide a great deal of user flexibility for creation of the shared memory window. All specifications such as window size, window base address, vector selection, vector base address selection and interrupt priority selection are selectable using on-board pencil switches. Window base address specification for each side of the memory window is selectable using 18 bits of address for Unibus computers and 22 bits of address for Q-Bus CPUs. Vector base address specification is selectable within a range of 0 to 774.

Because of the flexibility provided for sharing memory without any decrease in system performance, this peripheral processor link is useful for applications such as computer front-end, parallel processing, clustered computer systems or redundant processor configuration.

Roger Aouizerat, President, Ranyan Computer Enhancement Systems, 15239 Springdale St., Huntington Beach, CA 92649.

Write 232

COMPUTER DISC DIMENSIONS, DISC DYNAMICS, STRUCTURAL DYNAMICS, PARTS SORTING, SHAFT ALIGNMENT, VIBRATION, AXIAL RUNOUT, CONCENTRICITY, TURBINE BLADE PROFILING, THICKNESS, ID, OD, TURBINE BLADE PR
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YOU NEED ONE OF THESE.



Kaman Instrumentation's new KD-4000 Series, the "smarter" displacement measuring systems (with resolution to better than 1 micro inch) do more than give you raw analog displacement data that you still have to process and analyze.

With the KD-4000 Series you can specify the system functions that fit your application needs: ID, OD, Thickness, Alignment, Comparator Logic (for parts sorting, computer interrupts, etc), TIR, and more "smarts" on the way.

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The KD-4000 Series, for more complete solutions to your precision measurement problems. For more information, please write, or call us (303) 599-1825.

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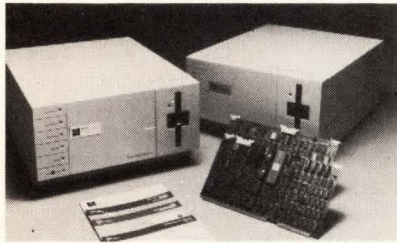
KAMAN INSTRUMENTATION CORPORATION
 P.O. Box 7463
 Colorado Springs, CO 80933

Write 39 on Reader Inquiry Card

COMMUNICATIONS COMPUTERS

Link Non-Networked Devices & Connect Ethernet To Long-Haul X.25 Networks

This family of programmable communications computers implements a distributed data processing environment by linking diverse devices through the Ethernet local area network, and linking Ethernet to remote devices across long-haul X.25-interfaced pub-



lic data networks. The Ethernet System Product Line (ESPL) has a system throughput of 1 Mbit/sec through all layers of protocol, and offers approximately five times the performance of existing network access systems. The first two members of the ESPL family are the Communications Server/1 (CS/1), which allows up to 32 non-networked devices with RS232 or RS423 serial interfaces to connect to an Ethernet network; and the Gateway Server/1 (GS/1), which connects an XNS Ethernet network to a host or network with an X.25 interface. The CS/1 is \$9900; the GS/1 is \$15,000; an Ethernet Controller/1 (EC/1) is \$3000. Qty discounts available. **Bridge Communications**, 10401 Bubb Rd., Cupertino, CA 95014.

Write 132

VAX CONVERSION PACKAGE

Converts PDP-11 Assembly Language To VAX-11 Native Mode

CONPAX Release 2 adds capabilities for handling system calls, floating point arithmetic, and other conversion problems. Handling of mixed operand integer arithmetic (by converting either to macros or to in-line code) helps migration to the 32-bit environment. Some new features take advantage of the more powerful VAX architecture, by helping (for example) to convert position-dependent PDP-11 code to position-independent VAX-11 form. Other features include optional conversion of numeric constants to decimal or hexadecimal. A permanent single-user license costs \$5000 for one CPU; additional CPUs can be li-

censed at substantial discounts. A service bureau license is also available. **Pennington Systems Inc.**, 65 S. Main St, Building C, Pennington, NJ 08534.

Write 149

MICROSYSTEM

Allows User To Build A Complete LSI-11 System

The RLX1001B incorporates a 10.3 Mbyte, 5¼" Winchester disk; 1 Mbyte, 8" RX02-compatible floppy disk; a built-in Q-bus card cage with 8 quad-height slots; and a 7" high desk-top or rack-mountable enclosure. LSI-11 processor, memory, and interface cards are also available direct from Charles River Data Systems. It is directly competitive with DEC's newly-announced MICRO/PDP-11 Winchester microsystem. LSI-11 users will be able to swap programs and data directly between existing systems



and the RLX1001B, through their RX02 floppies. This will not be possible with the MICRO/PDP-11. The RLX1001B runs under RT11 and RSX11M operating systems. Base price is \$7500. With LSI-11/23 processor, 256 Kbyte memory, and DLV11-J quad serial interface, total system price is \$9995. Main memory can be expanded to 1 Mbyte. Qty discounts avail. **Charles River Data Systems**, 4 Tech Circle, Natick, MA 01760.

Write 133

COLOR RASTER WORKSTATION

Working Palette of 16-256 Colors

From a total palette of 16.8 million colors, users can create a working palette of 16 colors for color coding graphic data, with expansion capabilities to 256 colors. Picking a color from the working palette displayed on

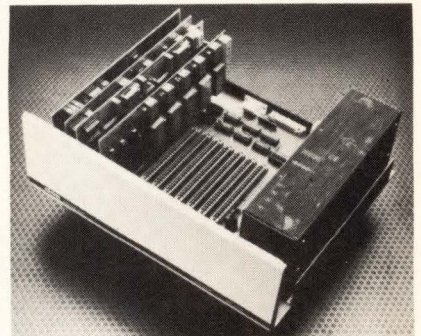
the screen simply by pointing to the desired color with the cursor, users may apply colors to individual data elements or to entire levels of data. Display resolution is 1280 × 1024 × 4 pixels. Function and alphanumeric keyboards have been designed for maximum operator comfort. Separate command and message displays keep graphics uncluttered. **GST**, 40 Gerber Rd E., S. Windsor, CT 06074.

Write 137

MEASUREMENT AND CONTROL SYSTEM

Complete Language System For Data Acquisition And Analysis

One general purpose system and three pre-configured systems make up the initial four-member DAS Series 500 family for the Apple II µC. The four systems are: the modular, general purpose System 500, which may be configured for virtually any combination of analog and digital inputs or outputs; the System 510, a high performance data acquisition system for applications requiring analog-to-digital conversion; the System 520, a complete measurement and control system with analog input and output, digital input and output, and power device control capabilities; and the System 530, a system that combines



unusually high resolution, low noise, and speed for accurate digitization and generation of complex analog signals. All Series 500 systems are fully modular and may be expanded through DAS's comprehensive I/O module library. All systems accept up to 12 modules in any combination, resulting in great flexibility in tailoring systems for various applications. \$2700 for System 500 with I/O modules priced separately. Pre-configured systems are: System 510, \$2900; System 520, \$4100; System 530, \$4400. **Data Acquisition Systems Inc.**, 349 Congress St., Boston, MA 02210.

Write 135

C EXECUTIVE

Support For National's NS16000 μ P

The C Executive is a small, execute-only memory-resident monitor for programs written in the C language or Pascal. It is designed to meet the needs of users who wish to run multiple C and/or Pascal programs in a

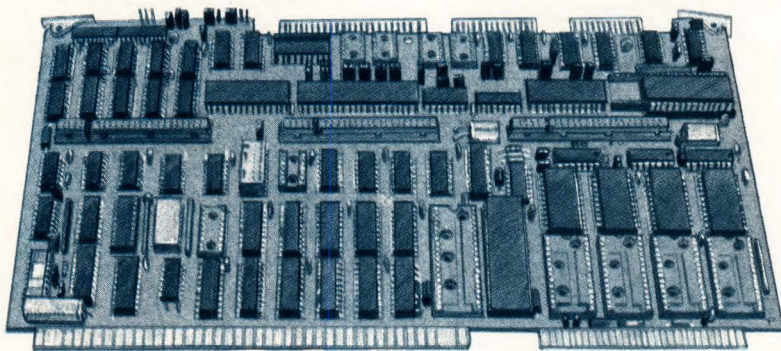
minimum hardware configuration where disk sub-systems are not appropriate. It allows multiple tasks to run concurrently with inter-task communication, resource coordination, and formatted I/O. Multiple user terminals, if needed, can be accommodated with dynamically-defined terminal characteristics. With the exception of

a few routines dedicated to disk I/O, all Pascal standard procedures and functions and the entire standard portable C library are supported. Single unit price is \$300, qty discounts available. **JMI Software Consultants Inc.**, 1422 Easton Rd, Roslyn, PA 19001.

Write 142

The Battle of the Giants Goes On!

ZX-86™ Single Board Computer.



Four ways we lick the Giant's 86/05:

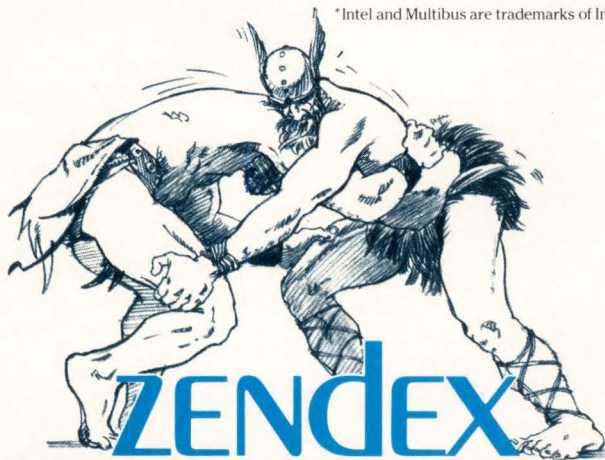
- **On Board Socket for 8087 Numeric Data Processor.**
- **Three SBX Expansion Connectors (to their two).**
- **Two Serial Ports with Optional MK3884 SIO (to their one).**
- **Multi-layer board design provides ultra-low noise levels.**

The ZX-86 is an 8086 based single board computer which is fully soft-

ware transparent to code written for the Intel® SBC-86/05. The ZX-86 offers additional features not found on the Intel boards including an on-board socket for an 8087 numeric data processor, three SBX connectors and two serial ports. The ZX-86 can be ordered with 5, 8, or 10 MHz Processors thus providing higher performance, expandable and flexible solution for OEM applications.

When we beat The Giant, you win.

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The other giant in the Multibus® market.

6644 Sierra Lane, Dublin, CA 94568. (415) 828-3000. TWX 910 389 4009.

Zendex products are available worldwide. Call or TWX for your local distributor.

CAD/CAM SYSTEM

Brings Power of CADAM To Minicomputer CAD Users

The System 8000 combines Vector General's VG 8250 display station with a 32-bit IBM-compatible main-frame computer and a full range of storage and other peripheral devices. The system runs either CADAM Inc.'s CADAM software or Northrup Corp's N-CAD software, or both concurrently. The computer used in the System 8000 is the System 312, manufactured and supported by Motorola's Four-Phase Systems Group. Comparable in power to the IBM 4341-1 or



the System/370 Model 148, this computer can support up to 12 VG 8250 display stations and communications lines in a CADAM environment. A full range of support options are available including plotters, digitizers, and large screen displays. Total hardware cost for a 12-station system is \$540,000, or \$45,000 per workstation. This system set also includes 4 Mbyte active memory, 400 Mbyte disk storage, a 1600 bpi magnetic tape drive, a 600 lpm printer, 3 selector channels, and an integrated communications controller. **Vector General**, 21300 Oxnard St, Woodland Hills, CA 91367.

Write 150

Write 50 on Reader Inquiry Card

LOCAL AREA NETWORK

Interconnects Vector 4 μ Cs

LINC (Local Interactive Network Communications) utilizes telephone wire to interconnect the Vector 4 family of single-user μ Cs into a flexible and expandable multi-user system. Also introduced is the Vector 4 Intelligent Workstation, a full-function μ C with no local disk storage that is a



minimum-cost configuration for a LINC workstation, ready to plug onto the Vector LINC network. The network permits the sharing of large disk files, high-speed printers, communications facilities and electronic mail service by any Vector 4 Computer attached to the network. Each workstation can support an individual printer and retains full capability as a standalone word or data processor for non-network functions. Any Vector 4 system can communicate with as many as 15 additional Vector 4 computers using standard dual twisted pair telephone wire, with workstations placed up to 2,000' apart. Daisy chaining stations allows LINC to extend almost two miles. The LINC Upgrade Kit can be purchased as an option for either the Vector 4/20 or 4/30 at \$750 including the basic LINC network software. The Vector Intelligent Workstation is \$3750. **Vector Graphic, Inc.**, 500 N. Ventu Park Rd, Thousand Oaks, CA 91320. **Write 151**

CAE WORKSTATION

Ethernet-Based, Integrates Engineering Office

The LOGICIAN line of CAE workstations creates a unified methodology that serves the designer from functional description to simulated and certified design. LOGICIANS can share access to high-speed printers and plotters, mass storage periph-

als, and gateways to remote networks. These workstations also access files resident on other workstations. In addition to the Ethernet universal interface capability, this integrated engineering office (IEO) adds a set of local tools: an interactive logic simulator, timing verifier, virtual logic analyzer, stimulus/test pattern generator, text and graphics merging capability, and SPICE circuit simulation. It also offers the user complete local application programming in FORTRAN, 77 PASCAL and PL/M, plus data base access. LOGICIAN (\$85,000 per terminal) offers $\frac{3}{4}$ Mbyte of RAM and a 40 Mbyte Winchester disk. It is built around a Multi-Bus architecture containing multiple processors, including an 8MHz Intel 8086 and Daisy's proprietary graphics processor. A UNIX-like operating system provides a multi-user networking environment. **Daisy Systems Corp.**, 139 Kifer Court, Sunnyvale, CA 94086. **Write 127**

IBM PC-COMPAT COMPUTERS

A Portable And A Desktop System

The units share complete software and hardware compatibility with the IBM PC, while also offering capabilities for extensive expansion. They include a 320K half-height diskette drive, a high resolution green-phosphor monitor, 128K memory, both a serial port and a parallel port, high resolution graphics, MS DOS, Basic with graphics commands, and a spread sheet software package. A second half-height floppy diskette drive and/or a 10 Mbyte hard disk can be added. In the standard-size Corona



PC, two floppies and the hard disk can be installed directly into the computer, with no external attachments. In the portable, the hard disk is a separate attachment. Standard size Corona PC with a single 320K diskette

drive is \$2595. With a second floppy, the price is \$2995. A system with an internal 10 Mbyte hard disk and a single diskette drive is at \$4495. The Portable PC is \$2395 with a single 320K diskette drive, and \$2795 with dual diskettes. The 10 megabyte expansion for the portable is priced at \$2695. These prices include 128K memory, monitor, ports, graphics, MS DOS, Basic, and spread sheet package. **Corona Data Systems**, 31324 Via Colinas, Suite 110, Westlake Village, CA 91361. **Write 134**

SCHEMATIC DESIGNER

Turns IBM PC Into Workstation For EE's

Unlike most other CAE workstations, the DASH I (Design Aid Schematic Helpmate) is not aimed at custom VLSI chip design. Instead, the DASH I schematic designer converts the IBM PC into a comprehensive design aid. Software, a proprietary graphics



controller, a "mouse," a memory network interface card, and a printer-plotter are added to the standard IBM PC. The designer can create, update, and print schematics quickly and easily. Components can be moved or deleted and the circuit modified or replicated in seconds. The system compresses the contents of a typical D-size schematic into an 11" x 17" drawing which is produced by the printer. All schematic data are captured on the built-in floppy disk. The data are then usable as input for a series of other programs that further increase productivity and reduce cost. A built-in design checking program detects and flags common errors, provides loading analysis data, and advises the designer of spare chip availability. The user also has access to all other software available for the PC. Complete system is \$12,960 (\$5960 if the user already has an IBM PC and Printer). **FutureNet, Inc.**, 21018 Osborne St., #5, Canoga Park, CA 91304. **Write 128**

8" WINCHESTER DISK

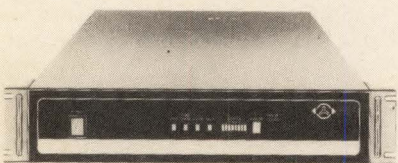
Features 80 MB Of Storage

The CDC 9412 Windsor features a data transfer rate of 1.2 Mbytes/sec with an average access time of 25 ms. Data is recorded on three disks at densities of 10,161 bpi and 735 tpi. It is completely interface compatible with Control Data's Lark family of 8" fixed/removable drives. Both units incorporate the standard Lark Device Interface (LDI) with a two-cable connection between controller and drive that features an 8-bit bi-directional bus for command and status transfers. The units can also be adapted to the industry-standard SMD interface through the use of an optional adaptor board. Other standard features of the Windsor include: extensive use of LSI electronics and μ P control; head positioning through use of a rotary voice coil actuator; and a fixed, sealed head disk assembly. The CDC 9412 Windsor drive, with the standard LDI is \$2750 in OEM qty. **Control Data Corp.**, Box 0, Minneapolis, MN 55440. **Write 163**

CONTROLLER/FORMATTERS

Mag Tape Controller And Personality Modules

The Series 2600 product line permits users to easily and inexpensively move the IBM-compatible magnetic tape peripheral from one application to the other. The series offers compatibility among a variety of tape transports up to 75 ips and a host of



computer systems. Housed in single standard 3½" by 19" rack-mountable cabinet, it typically contains two PC cards—an industry-compatible magnetic tape formatter (for unformatted tape transports), a μ P based intelligent controller; a variety of personality modules allows it to interface with various standard busses, such as RS-232C, IEEE-488 and an 8-bit parallel I/O. From \$2495. **Innovative Peripheral Systems**, 4060 Morena Blvd, San Diego, CA 92117. **Write 172**

DATA LINE MONITOR

Full Keyboard Programmability

DLM V's menu guided programming language consists of 15 instructions and 11 commands. Each test program can be up to 72 steps in length. Edit and update capability permits modifications of finished programs without tedious rewriting. E²ROM capability gives operators an easier way to run repeatable interactive tests. Up to 10 named programs can be stored simul-



taneously in the non-volatile E²ROM memory. An optional MSU IV Dual Diskette subsystem expands the DLM V's storage capacity and off-line diagnostic capability. **Digilog Network Control Div.**, 1370 Welsh Rd, Montgomeryville, PA 18936. **Write 164**

160 MB 8" WINCHESTER

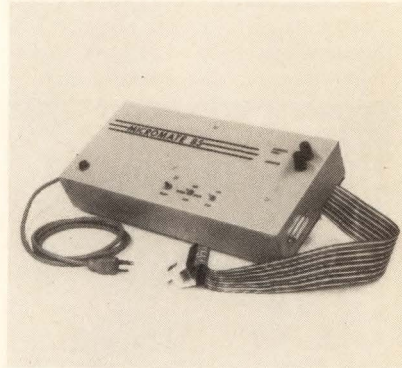
Uses Thin Film Plating Technology

Data is carried on 4 thin film fixed disks. Seven surfaces, each served by a dedicated R/W head, carry data. The 8th surface is reserved for track following servo information. Average access time is 30 ms. The D-1600 has the same form factor as a standard 8" floppy drive. It uses standard voltages (+5, +12, +24). ANSI-standard and SMD interfaces are available. On-board diagnostics, accessible through RS-232 port, and 7-element LED readout provide for troubleshooting without requiring access to the host. Self-contained shock mounting, internal carriage lock, and thin film Winchester media allow use in portable and industrial systems as well as in conventional commercial installations. \$1980 (OEM qty); discounts available for larger quantities. **Disctron**, 1701 McCarthy Blvd, Milpitas, CA 95035. **Write 165**

8085 μ P ANALYZER

Real-Time Diagnostic And Development System

Lightweight and portable, the MICROMATE 85 is used for software development and debugging, produc-

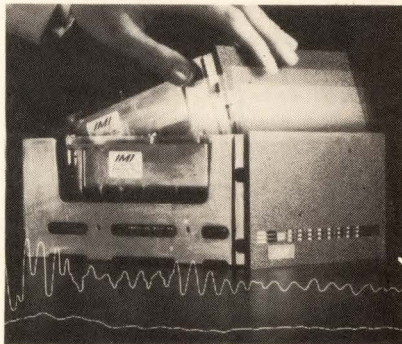


tion testing and field service. It does not replace or emulate the 8085; it is attached by a clip to the Processor and provides real-time program analysis. It allows you to examine and modify memory locations and registers at any point in the operating program through the use of addressable traps. The operating program may be started or stopped at any location, or the program may be stepped one location at a time. Under \$800. **Essex Engineering Co**, Industrial Park, Essex, CT 06426. **Write 167**

42MB 5-1/4" WINCHESTER

Extension Of 5000H Family

The 5040H contains 3 disks, has 600 tpi and is ST506 compatible. Average access time, including settling time, is 68 ms. It is fully shock mounted for

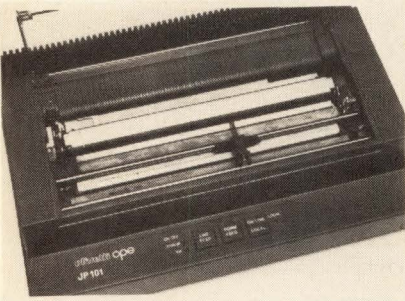


ruggedness, uses thin-film plated media for better performance and durability, has a thermally stable design for fewer off-track errors, and uses head mounted pre-amps for noise immunity. Comes with standard 2-year warranty. **IMI**, 10381 Bandle Dr, Cupertino, CA 95014. **Write 171**

DRY INK JET PRINTER

Low Cost Hard Copy For Desktop Micro's

The JP101 is a noise-free 80 cps printer. The printhead consists of a disposable glass ampule that contains a dry ink cartridge. It has a life of between 150,000 and 200,000 characters, and can be replaced for about one dollar.



The printer consists of a single PCB, a power supply, and the mechanical assemblies for head and paper movement. It measures 4.5" H by 15" W by 10" D. Draft quality alphanumeric print is in three basic modes: 10 cpi over 80 columns in a 7x7 matrix, 12 cpi over 96 columns in a 7x7 matrix, or 18.25 cpi over 146 columns in a 7x5 matrix. Bit-map graphics are 110x110 dpi with 880 dots/8" line. It has a standard 8-bit parallel interface, with optional RS 232-C or current loop interfaces. Handles roll paper 8.5" wide and fanfold paper 8 to 9" in width. **Irwin Olivetti, Inc.**, 2000 Green Rd, Ann Arbor, MI 48105. **Write 173**

PROTOCOL ANALYZER

Simplifies Datacom-Network Analysis

The HP 4955A will serve EDP centers, computer and communication-equipment manufacturers, and carriers. In full duplex operation, it provides speeds from 50 bits/sec to 72 Kbits/sec. It includes internal RAM



mass storage of 128K words for storing data, lead status and timing. By using the 63 separate triggers, it can

search simultaneously for multiple events. The user has a choice of 7 display formats on the 9" CRT and the HP 4955A can be connected to networks through a variety of physical interface pods (RS-232C/V.24, RS-449, V.35, MIL-188C). In addition, no formal programming skill or language is required. For many of the protocols or physical interfaces available today, an exact replica of events as they occur can be stored by the HP 4955A on tape. When real-time analysis is not sufficient, tape storage allows later examination of the data in more detail. Set-up and measurement sequences also can be stored on tape, then down-loaded when necessary. \$20,950. The BASIC language option is \$2015, and the physical interface pods are \$1110 each. **Hewlett-Packard Co.**, 1820 Embarcadero Rd, Palo Alto, CA 94303. **Write 170**

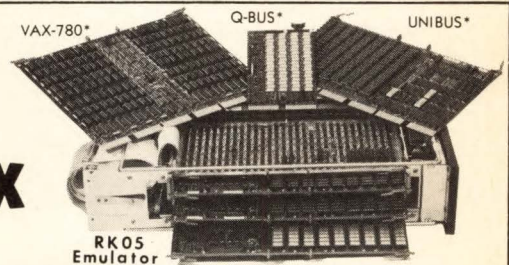
COMMUNICATIONS SYSTEM

For The Professional Personal Computer User

The Professional Communications

System (PCS) includes a Bell 212A or Bell 103 compatible modem and up to 64K RAM of message buffer. The PCS/1200 and the PCS/300 provide unattended, scheduled, error-free message reception and transmission even while the personal computer is running other applications such as word processing or Visi-Calc. The PCS is designed primarily for use in medium to large corporations, or by individuals who want to share files with other personal computers and who want access to centralized data bases or public information utilities. In addition to its file and message communications capabilities, the PCS provides a user-configurable printer/buffer, simultaneous printing and display of received information and an LCD time-of-day clock. All other functions of an intelligent modem, including stored telephone number capability with automatic redial, are performed by the PCS. The PCS/1200 with 16K RAM is \$995; with 64K RAM, \$1095. The PCS/300 with 16K RAM is \$595; with 64K RAM, \$695. **MICROCOM, Inc.**, 1400A Providence Hwy, Norwood, MA 02062. **Write 175**

Add-In or Add-On, Add CAMBEX



We'll meet your needs. Our DEC compatible MicroSTOR, ExpandaSTOR, SuperSTOR and VA-780 memory systems have ten plus years of production experience behind them. And experience counts when it comes to improving memory. It's given Cambex versatility, creativity, and reliability. Whether it's a single system or volume output the designer requires, we have both the technology and flexibility to fill the order at a competitive price. Beyond that only multiple source, full spec components will be used and each system will be individually computer-tested with a one year warranty.

So, if you've got a PDP-11*, LSI-11* or VAX and memory's a problem, call Cambex. We'll meet your needs.

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MULTIPLIERS & MULTIPLIER/ACCUMULATORS

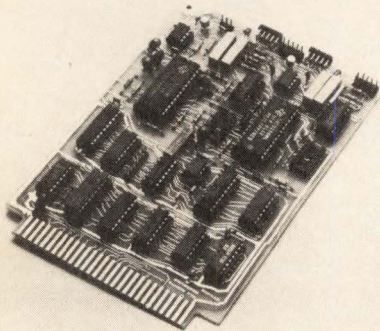
Built On A Low-Power CMOS Process

Four pin-compatible second sources to industry-standard 8X8- and 16X16-bit multipliers and multiplier/accumulators offer speed comparable to bipolar and NMOS devices but dissipate approximately 1/20 the power. All models are available processed to MIL-STD-883B; low-power dissipation allows the devices to be offered in flatpacks. All models provide 3-state outputs, TTL-compatibility, and the necessary control inputs and outputs for interfacing to 8- and 16-bit μ C buses. From \$45 to \$198 in 100 qty. **Analog Devices, Inc.**, Two Technology Way, Norwood, MA 02062. **Write 186**

SPEECH SYNTHESIZER/TELEPHONE DIALER

Brings Speech Synthesis to STD Bus

Based upon the TI TMS5220, which utilizes the linear predictive coding method of speech synthesis, the ST4406 provides intelligible speech output with a minimal system memory requirement. Available in either one channel (ST4406-0) or two channel (ST4406-1) configurations, the board also has automatic pulse dial capability and relay controlled remote enable outputs. When connected to

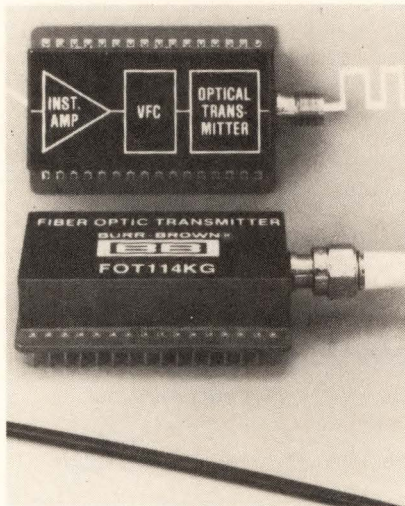


the telephone network through a registered CBT-type coupler, the device may be used to answer incoming calls, generate a spoken, pre-programmed message, and then enable a remote tape recorder or other device. The ST4406 is delivered with a complete software support package. The ST4406-0 (1 Channel) is \$335; ST4406-1 (2 Channel), \$385. OEM and qty discounts avail. **Applied Micro Technology, Inc.**, PO Box 3042, Tucson, AZ 85702. **Write 187**

FIBER OPTIC TRANSMITTER

IC-Packaged Analog Input VFC Device

The FOT114 analog fiber optic transmitter combines high sensitivity and linearity with safe operation for data transmission applications in noisy and/or hostile environments. Dangers of sparking are eliminated in explosive atmospheres such as refineries and chemical plants. It is capable of

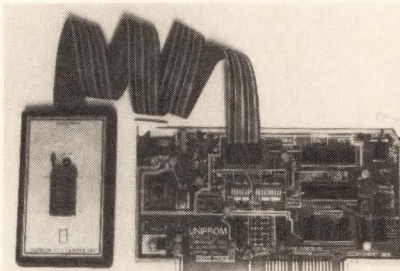


transmitting analog input signals as small as 10mV full scale for distances up to 2.4km with a typical linearity error of only $\pm 0.01\%$; the powerful IR infrared version can transmit signals up to 9.7km. Prices (qty 1-24) are \$116 for the "KG" version; \$120 for the "KG-IR" infrared. A special introductory kit containing a FOT114 transmitter, a FOR110 TTL receiver, an OCA201, 10-meter fiber cable assembly, and 2 connector sockets is \$188. **Burr-Brown**, Analog Products, Box 11400, Tucson, AZ 85734. **Write 188**

EPROM PROGRAMMING CARD

For The S-100 Bus Computers

UNIPROM enables S-100 bus computers with 8080, 8085, or Z-80 μ Ps



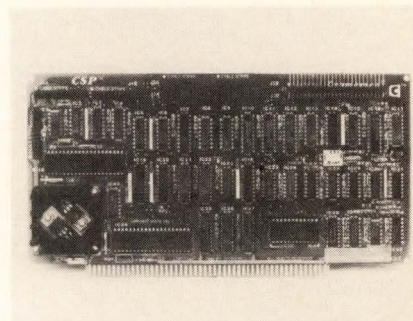
to read/program the 2704, 2758, 2508, 2708, 2516, 2716 (1 supply), 2532, In-

tel's 2732, 2732A and Intel/NEC 8755A. In addition, the system may be easily programmed to read/write/erase the 16K EEPROMs. Further, the manual shows how most non-S-100 buses can be modified to operate with the system. The software is user friendly. The system operates at rates in excess of 6 MHz and is port mapped so as not to occupy memory space. Personality modules are not required. The card is \$199. CPM and CDOS compatible software is \$38 on 5 1/4" Northstar diskettes or 8" IBM 3740 diskettes, and for \$55 in an EPROM (for non-standard systems). **Cer-Tek, Inc.**, 6020 Doniphan Dr, El Paso, TX 79932. **Write 189**

SERIAL/PARALLEL INTERFACE BOARD

Adds I/O Capability To C-Bus Based Systems

The Model CSP provides 3 parallel ports and 2 serial ports and is capable of handling rapid data bursts. Two of the 3 parallel ports are TTL-buffered for general usage. The third port is buffered by a FIFO shift register to permit input and output of rapid bursts of data. For example, up to 16 bytes can be stored in the FIFO at I/



O clock rates up to 10 Mbytes/sec. The 2 serial ports are single full duplex serial channels designed to facilitate communications applications. One port for sync communication (SDLC or HDLC) at rates up to 800 Kbits/sec. The other port is a serial RS232 interface for async communications and can be programmed for any data rate up to 9600 bits/sec. The CSP and peripherals connected to the C-Bus are controlled by a single Model IOP card. The CSP appears to the IOP as 12 input and 13 output ports. It can issue maskable C-Bus interrupt requests and supply interrupt vectors during interrupt acknowledge from the IOP's Z-80A processor. **Cromemco Inc.**, 280 Bernardo Ave., Mountain View, CA 94043. **Write 191**

CUSTOM 212A COMPAT MODEM

Utilizes Digital Signal Processor Techniques

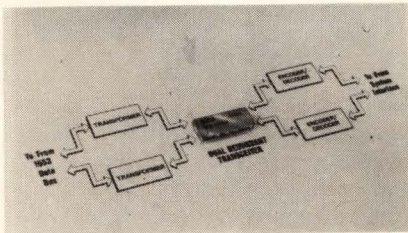
The CTS Series 828 modem utilizes digital signal processor techniques not previously applied to modem design. Both the μ P and signal processor used in the modem permit the replacement of many conventional circuit components by software resulting in superior performance, reduced board size and competitive price. Bit error rate performance is better than 1 in 10^5 (at a S/N of 12dB). Digital-to-analog and analog-to-digital conversion is performed with a front-end dynamic range of -72dB. The dynamic range of the entire modem (important for reliable communications over poor quality telephone lines) is in the area of 0 to -45dBm. A typical custom modem will operate at 1200bps DPSK synchronous and asynchronous plus 300bps FSK asynchronous, full duplex in the originate, answer and automatic answer modes. Automatic DTMF and pulse dialing with automatic redialing is provided. Two

USOC RJ-11C modular phone jacks allow both voice and data transmission over the phone line. From \$200 to \$300 in OEM qty, depending upon the features and interface requirements specified. **CTS Corp.**, 1201 Cumberland Ave, W. Lafayette, IN 47906. **Write 192**

MIL-STD-1553 TRANSCEIVER

Small, Dual Redundant Device

BUS-63125 contains two custom LSI transceiver chips which reduce size substantially, requiring only 1.5 sq. in.



of PC board space. Housed in a 36 pin double dual in-line package, it contains two completely isolated transceivers. There are no electrical

paths between the two circuits which are completely separate to maintain true dual redundancy. Features low power, improved filtering to enhance bit error rate, short circuit protection and a time-out circuit for each channel. The BUS-63125 is TTL compatible and operates with $\pm 15V$ or $\pm 12V$ power supplies. \$358 each in 100 qty. **ILC Data Device Corp.**, 105 Wilbur Place, Bohemia, NY 11716. **Write 197**

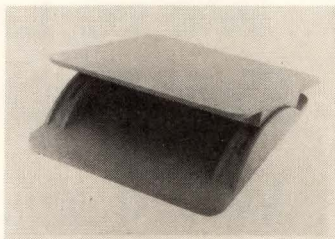
MODIFIED EEPROM

700 Bit Serial Device

ER1451 is a TTL compatible, 700 bit version of the General Instrument ER1400. Features include 50 word $\times$ 14 bit organization, 10 year storage capability, word alterability, and 10ms write and erase time. It is fully compatible with the ER1400 socket with minimum grounding reconfiguration. In all other aspects, the device is exactly compatible with the existing ER1400. \$1.65 in 10K qty. **General Instrument Corp.**, Microelectronics, Div., 600 W. John St., Hicksville, NY 11802. **Write 196**

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DIGITIZING/RECOGNITION DEVICE

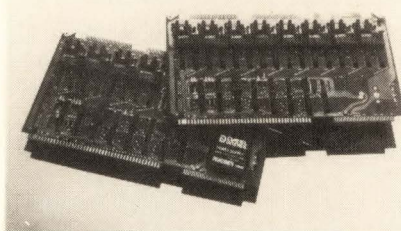
Replaces Keyboard and Digitizer As Main Input Device

AUDRE (AUtomatic Digitizing & REcognition) can capture an image of any object using a high resolution digitizing camera coupled to a high performance minicomputer. Input image resolution of 1720×2592 pixels translates to 200 points/in for an $8\frac{1}{2}'' \times 11''$ document. The image is transferred to computer memory and display monitor simultaneously at over 1 million pixels/sec. The minicomputer is a bit slice TTL processor supporting 768×1024 bit mapped display, tablet, 24 Mbyte hard disk, floppy disk, and 1 Mbyte MOS memory. Ethernet, RS232 and GPIB communications are supported. Applications include photogrammetry, mapping, text processing, circuit inspection, engineering design and drafting, and CAD/CAM resource management. Camera, interface, minicomputer and utility software is \$49,700. **Data-Stat Co.**, 1081 Alameda St, Suite 103, Belmont, CA 94002. **Write 193**

MULTIBUS D/A BOARD

An 8 Channel, 16 Bit Resolution Board

The ST-716 16-bit D/A boards (14 bit monotonic) are form and fit compatible with Multibus based computers. They are memory mapped for easy software control and provide standard output ranges to simplify interfacing with industrial controls and instru-



mentation equipment. It is a "dedicated" computer D/A output board and appears to the host computer as a string of contiguous memory addresses (memory mapped). The base or lowest address can be positioned by the user anywhere in memory allowing additional ST-716 boards to be added. Compatible with both 8 and

16 bit Multibus based systems (including the iAPX 86/12 and SBC-86/12) and supports 20 bit addressing. Bus input registers are double buffered. ST-716-A, 4 D/A channels, \$690; ST-716-B, 8 D/A channels, \$995; ST-716-C, 4 D/A channels with DC to DC converter, \$745. **Datel-Intersil**, 11 Cabot Blvd, Mansfield, MA 02048.

Write 195

Erratum

The photo appearing with the Hughes new product release "64K CMOS ROM" (*Digital Design*, January 1983, p. 86) was incorrect. The photo actually shows a custom chip designed by A/S Elektrisk Bureau of Norway that was created using the ZyMOS standard-cell library and "ZyP" design automation system. The echo-cancelling device packs 5000 transistors—plus a 1k CMOS static RAM—for modem applications. Further information may be obtained from: ZyMOS Corp., 4777 N. Mathilda Ave., Sunnyvale, CA 94088.

CALIFORNIA COMPUTER SHOW

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Palo Alto, CA.
Time: 12:00 - 6:00

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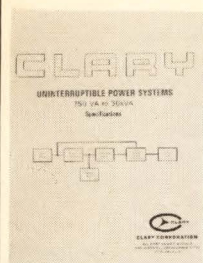
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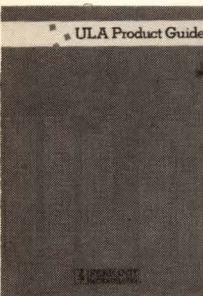
Guidelines. For guidelines to *Digital Design* article requirements, format, submission and acceptance, write to: Features Editor, *Digital Design*, 1050 Commonwealth Ave., Boston, MA 02215.



UPS Spec Sheet. A single page specification sheet describes the full line of UPS, and gives the full range of model numbers manufactured by Clary Corporation. Includes highlights of how various systems work along with detailed engineering data such as kVA, frequency (HZ) output amperes, harmonic distortion, weights and physical size of machines.

Clary Corp.

Write 250



Ferranti ULA Gate Array Product Guide. A full-color, 16 pp. ULA product guide describes the line of gate arrays. The guide features over 50 types of gate arrays, providing chip complexities from 100 to 10,000 gates and performances from CMOS power levels to ECL speeds. Included in the guide are a detailed explanation of the Ferranti ULA concept, product characteristics and generic specifications for both digital and digital/linear arrays.

Ferranti Semiconductors

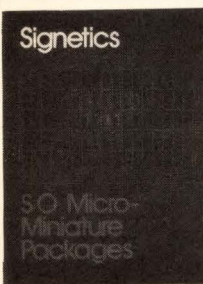
Write 257



Keyboard Design Guide. A 16 pp. full-color brochure describes design considerations for micromotion membrane keyboards. The brochure details keyboard types, graphics and aesthetics, design and manufacturing, and quality assurance, as well as tables, checklists, and a glossary. The guide was developed as an aid to design engineers specifying membrane keyboards, and explains the keyboard design process.

Rogers Corporation

Write 256



Miniature IC Packages. Signetics Corp. has released a brochure, entitled *SO Micro-miniature Packages*. The "SO" or small outline microminiature package supports the emerging manufacturing method known as surface-mounted device technology. The 16-pp. brochure catalogs nearly 200 available products in the small packaging in three major lines: TTL Logic (48 products), Linear (47 products) and LOC-MOS 4000 series (96 products).

Signetics

Write 262



SRL Color Display Brochure. A 4-pp. color brochure describes Systems Research Laboratories' Model 2106 In-line Color Display, that features 100 MHz video bandwidth, preconverted tube/yoke assembly and factory magnetic tuning, selectable multiple line/frame rates, and a 64 kHz horizontal frequency option. Standard features include differential video inputs and separate horizontal and vertical drive inputs.

Systems Research Labs.

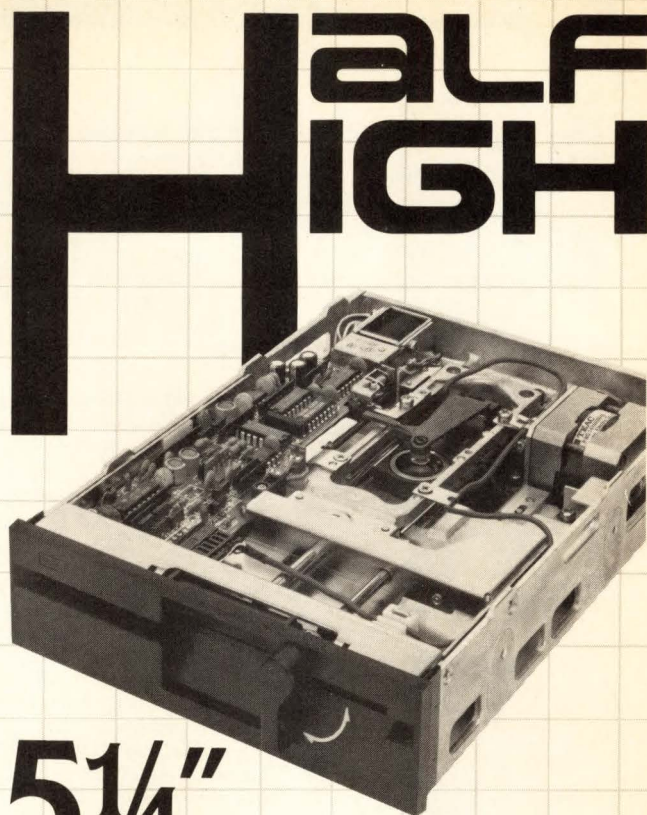
Write 265



Semi-Custom Brochure. A 6-pp. brochure describing the Cherry Genesis line of digital I²L Semi-Custom Integrated Circuits features numerous charts and diagrams illustrating the basic I²L gates, input-output interfaces, components available and basic layout rules for the three digital chip types: the 1200, 1300 and 1400. A detailed chart gives condensed data for seven linear circuits as well as the three digital types.

Cherry Electrical Products

Write 264



5 1/4" Floppy Disk Drives TEAC FD-55 Series

AT 1 5/8" HIGH, TEAC FD-55 SERIES 5 1/4" FLOPPY DISK drives use half the space and run cool at half the power of conventional drives. High-reliability, low-noise brushless DC motors provide an MTBF of over 10,000 hours, backed by a one-year parts and labor warranty.

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Power Requirements:

DC +12V $\pm 5\%$ 0.3A typical, 0.7A max.

DC + 5V $\pm 5\%$ 0.5A typical, 0.7A max.

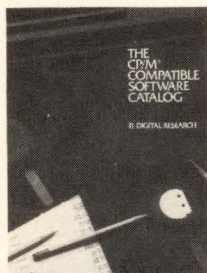
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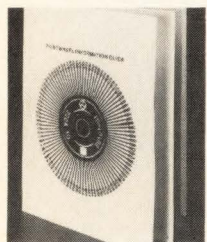
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CP/M Compatible Software Catalog. Keeps Digital Research customers informed of the number and variety of compatible application software products produced by independent vendors. Products are listed and described in detail according to DR language compatibility. Companies are also listed by the specific application program they produce.
Digital Research Write 255



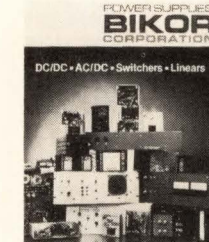
Printwheel Information Guide. An 8-pp. comprehensive booklet outlining the important aspects of daisy printwheels, is now available from AGT Computer Products. This new guide has sections on printwheel characteristics, how to identify compatible wheels, types of daisy wheels and care and handling procedures.
AGT Computer Products Write 259



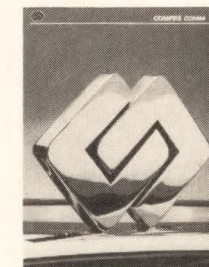
Semicustom Guide. An engineering guide to semicustom ICs provides design engineers with information for planning and determining design feasibility of semicustom integrated circuits for their applications. Included is a description of CDI's CMOS gate array families and their characteristic data, development flow of design, and discussion of arrays from logic simulation through computer aided engineering.
California Devices Write 271



Connector Literature. Augat Fiberoptics' step-by-step instruction sheet for their JSC and DSC crimpless connectors includes simple pictorial instructions. The sheet is fully detailed to eliminate confusion and result in complete connector termination in under 15 minutes yielding typical connector-to-connector losses of 0.9 dB (100 μ m core).
Augat Fiberoptics Write 261



Power Supply Selector Guide. A new 6-pp. Power Supply Selector Guide includes information on Switching Power Supplies and Linear Power Supplies. The new publication covers AC and DC Input Power Supplies, Open Frame and Modular Types and describes Custom Power Supply services.
Bikor Corp. Write 258



Modem Brochure. The Bi-Link 2-port statistical concentrator, used in conjunction with low or medium speed modems in full-duplex application, is illustrated in a new 4-pp. brochure. The Bi-Link allows users of 103, 202, or 212A type modem applications to concentrate 2 asynchronous interactive terminals on one phone line. Asynchronous network data rates may be up to 2400 BPS and terminal speeds may be switch-selected.
Compre Comm Write 266

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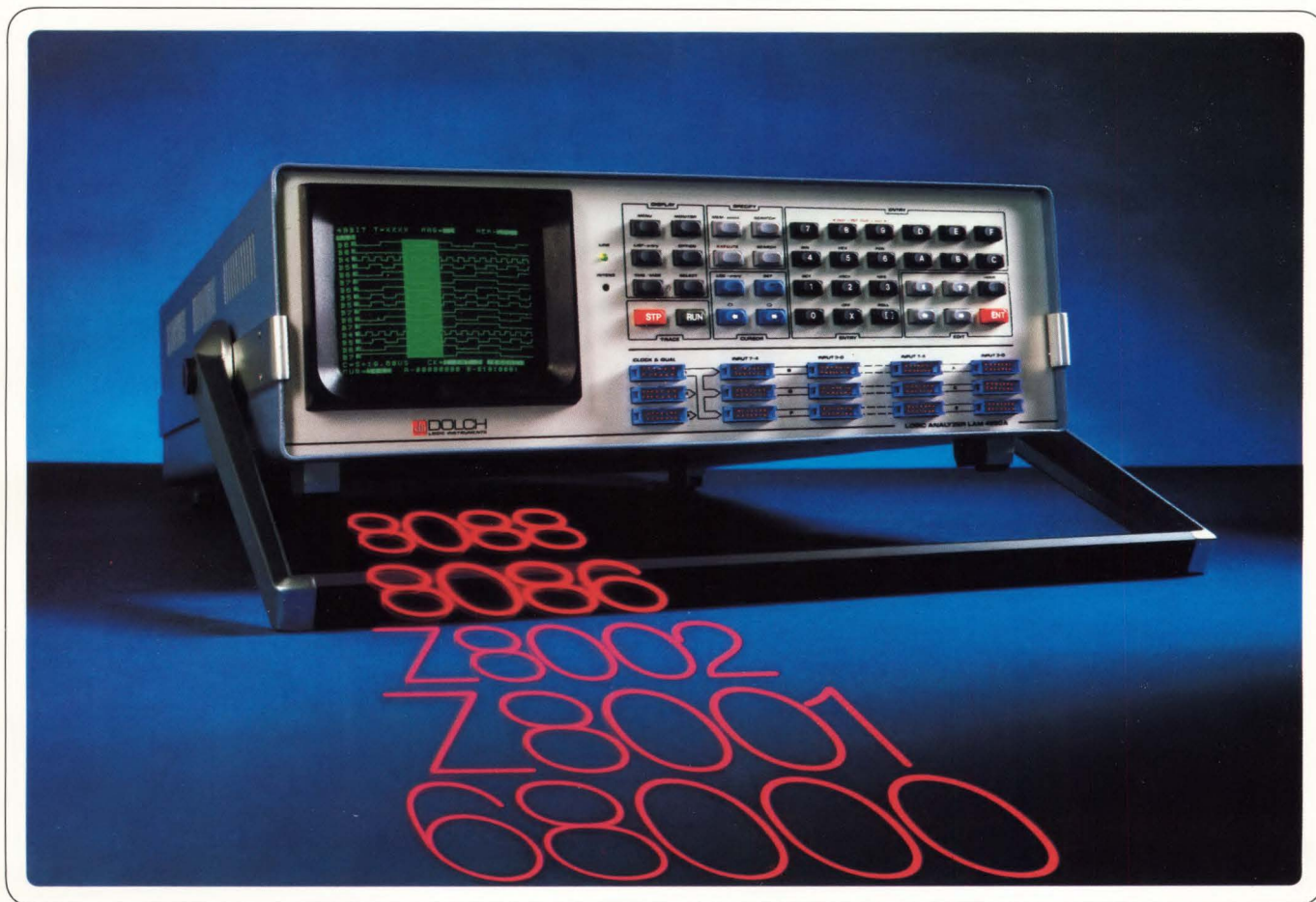
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advanced logic analysis



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Our Trace Module connects the 4850A directly to your 16 bit operating system. Signal interfacing and clock formatting are already done. (In the 68000 and 8086/88 systems, the Trace Module separates instructions executed by the microprocessor from all of those that were "pre-fetched" into the instruction queue.) The 4850A then disassembles and displays the

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tem's memory—there's no need to record unwanted data.

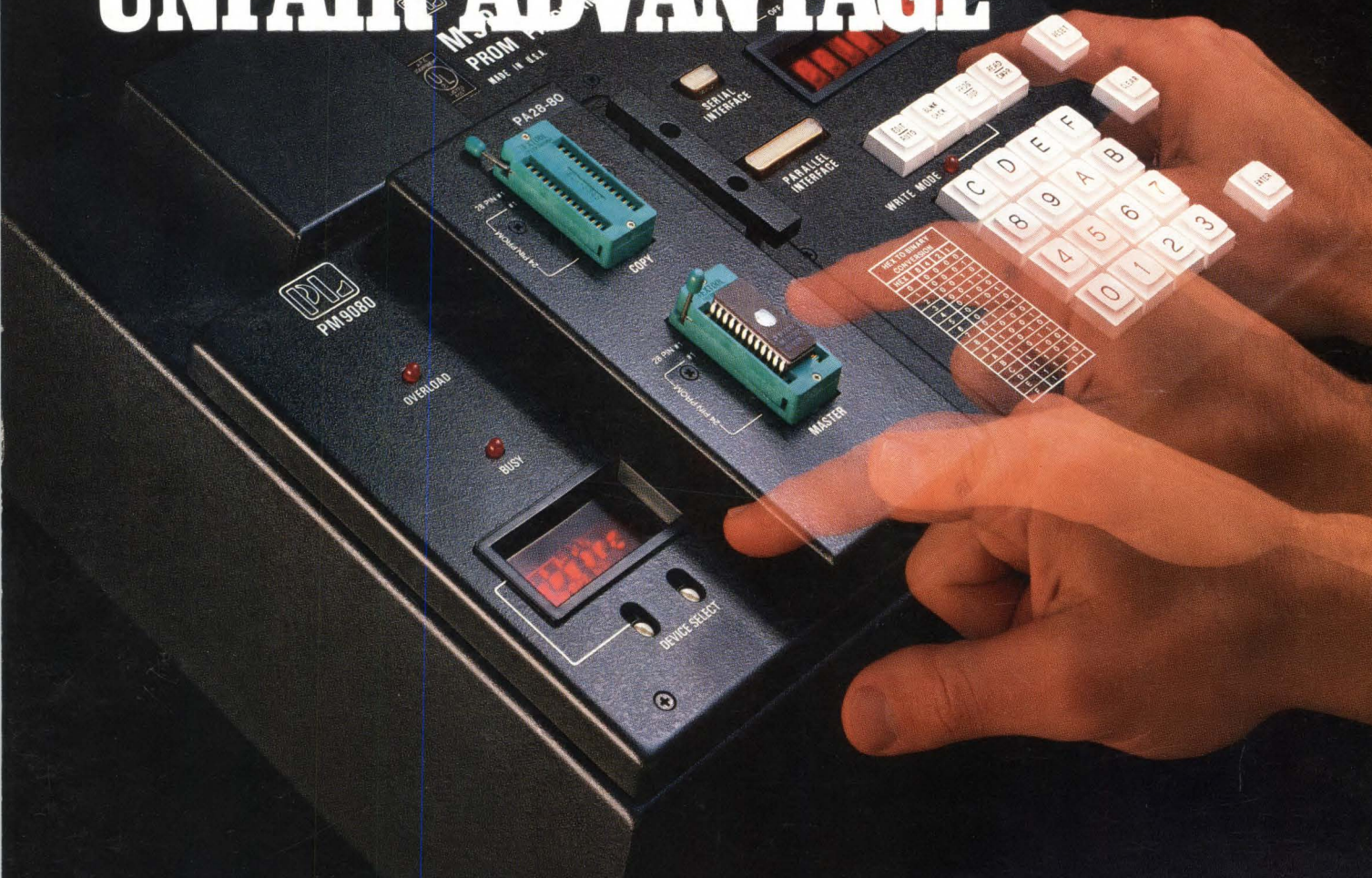
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